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ABSTRACT

The purpose of this notebook is to assist educators who are designing and implementing inservice education programs to facilitate the effective use of computer integrated instruction (CII) in schools. It is divided into the following five sections: (1) Effective Inservice (a brief summary of inservice literature focused on inservice dimensions and design principles); (2) Background Information (an overview of computers in education and a discussion of the roles of computers in problem solving); (3) Initiating/Planning an Inservice (suggestions for preliminary planning and activities and a sample timeline for those activities); (4) An Eight-Session Science Inservice (2-hour sessions include hypothesis testing using a computer, searching and sorting databases to generate and test hypotheses, creating a database for testing hypotheses, introduction to a spreadsheet, creating a spreadsheet, using an integrated package to produce a lab report, investigation of some commercially available science education software, and projects and closure); and (5) Instruments and Evaluation (a variety of instruments for needs assessment, formative evaluation, and summative evaluation). Each 2-hour science inservice session contains some or all of the following: narrative overview, script (topics, objectives, materials, activities), timeline, handouts, and readings. References are listed in the first three sections, and a software bibliography is included in the fourth section. (DB)

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COMPUTER-INTEGRATED INSTRUCTION INSERVICE NOTEBOOK: SECONDARY SCHOOL SCIENCE

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[**] Not all staff members worked specifically on the science inservices. A number of volunteers also contributed to this project. Lloyd Meskimen made significant contributions to this Science book.

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PREFACE

The purpose of this notebook is to assist educators who are designing and implementing inservice education programs to facilitate the effective use of Computer-Integrated Instruction (CII) in schools. CII involves the use of the computer as a problem solving tool. CII includes the use of applications such as databases, graphics, spreadsheets, telecommunications, and word processors; these are generic applications in the sense that they can be used in many different subject areas and grade levels. CII also includes use of special purpose software designed to help solve the problems occurring in specific courses or disciplines.

This notebook was prepared by the staff of NSF Project TEI 8550588, which received three years of funding beginning September 1985. It is one of four notebooks to be prepared that include:

- CI^3 Notebook for Elementary School
- CI^3 Notebook for Secondary School Mathematics
- CI^3 Notebook for Secondary School Science
- CI^3 Notebook for Secondary School Social Science

The problem addressed by this NSF Research and Development Project is the disparity between the overall capabilities and potentials of CII and the current implementation levels of CII in our schools. There is strong support from computer-knowledgeable educational leaders for increased use of CII.

Growth in appropriate use of CII depends on schools having:

1. Access to appropriate hardware.
2. Access to appropriate software.
3. Access to appropriate curriculum and instructional support materials.
4. Appropriately trained teachers and school administrators who support increased use of CII.

The cost of computer hardware continues to decline even as its capabilities continue to increase. The amount of computer hardware available for instructional purposes is now sufficient to have a significant impact on schools. Moreover, hardware availability is continues to grow very rapidly. This project assumes that the problem of hardware access will gradually diminish; thus, this project does not focus on the hardware problem.

The quantity of educational software is continuing to grow, while the average quality continues to improve. A 1986 estimate suggested that there were about 10,000 educationally oriented, software programs for microcomputers commercially available. *The Educational Software Selector* published by EPIE, lists nearly 8,000 titles. The amount and quality of CII software now available is adequate to support extensive use of CII in schools and to have a major impact on school curriculum. The educational market is large enough to support a viable, competitive industry with many companies participating.

This project does not focus on the overall problem of educational software. However, each Notebook contains information about a number of pieces of educational software. To the extent possible, the focus is on currently available generic CII software. In cases where more specific pieces of CII software are discussed, they were selected because they are readily available, and are apt to remain so for some years to come, and because they fit the specific instructional needs of the authors of these notebooks.

Instructional support materials include textbooks, workbooks, and reference materials; films, filmstrips, and video tapes; and course goals, course outlines, and teacher support materials. Although there is a substantial amount of instructional support material for learning/teaching about computers (teaching computer literacy, computer programming, and computer science), the amount of instructional support materials for CII is still quite limited. This project includes the development of a modest amount of CII teacher support materials; a number of sample lesson plans have been developed and are included in the notebooks, for example. It is not, however, a major goal of this project to develop CII instructional support materials.

The NSF Research and Development project focuses on the development of effective methods for the inservice education of educators interested in CII. The materials contained in the notebooks are intended for computer education leaders who are designing and implementing CII inservice education workshops and courses. Each notebook contains a detailed outline of an eight-session workshop along with support materials. A number of "Copy Me" pages are included for dissemination in an inservice workshop or course.

It is recognized that designers and deliverers of inservice education vary widely in their experience, computer background, and academic area of specialization. With this in mind, two general methods are envisioned for using the materials in these notebooks. First, an inservice provider might rely heavily on a particular notebook, following it closely in giving a sequence of workshops or a course. Second, an inservice provider might use these notebook materials to get ideas and to serve as resources in designing and presenting CII instruction to educators. In either case it is expected that the inservice provider will benefit from use of the notebook materials and will learn some new ideas about effective inservice and CII.

This notebook presents a particular philosophy of inservice education. It is a process-oriented philosophy, as distinguished from a content oriented philosophy. Thus, an inservice education program based on this Notebook will look quite different from the traditional computer-oriented inservices that have been widely presented in recent years. The resulting inservices are fun to lead and fun to participate in. They are an effective way to encourage the increased and appropriate use of computer-integrated instruction in schools.

How to Read and Use This Notebook

The purchaser of a single copy of this Notebook receives a print copy, a copy in MacWrite format on 800K Macintosh disks, a Microsoft *Works* (Version 1.0) Data disk, and a single user site license.

The single user site license gives the one person who is designated as the "Primary User" of the site license the right to make copies of all of the materials in this book for classes he or she teaches. If the single user site license is purchased by a school or school district, the intent is that one person be designated as the "Primary User." If several people are to teach using this book, a multiuser site license should be purchased. The right to copy materials from the book does not transfer to participants in classes taught by the "Primary User."

Information about purchasing a multiuser site license can be obtained from the publisher, the International Society for Technology in Education, 1787 Agate Street, Eugene, Oregon 97403.

The disk copy is organized into folders, sub folders, and individual files in a systematic and relatively logical fashion. At the bottom of each page of the print copy there is information that will help you locate the appropriate file on disk. The typical footer consists of three parts:

Brief title of the book: CI^3 Notebook
File name: This is explained in more detail below.
Page number within the specific file: Each file is numbered sequentially starting at page 1.

The name of an individual file is two or three digits, separated by periods, and a brief title. You will notice that the name of the file you are currently reading is 0.4 Read and Use. The first digit of the sequence is a folder number. This file is in folder number 0. The second digit refers to a particular file within the folder unless there is a third digit. If there is a third digit, the second digit refers to a subfolder number, and the third digit to a file within that subfolder.

This notebook contains a great deal of information to aid you in conducting an effective inservice for integrating computers into the curriculum. Most readers will want to skip around in the material, rather than reading it from cover to cover. This section is a guide to help such readers by presenting a brief summary of each section and how and when to use it.

Section 1: Effective Inservice

Substantial literature exists on effective inservice. This section of the Notebook contains a brief summary of the effective inservice literature followed by a discussion of the CI^3 model for the inservices designed for this NSF project. We recommend that you read all of this section.

Section 2: Background Information

The first part of this section is a general overview of computers in education. It might be used as a handout at an inservice for educators who have not had previous coursework or extended workshops on computer uses in schools.

The second part of this section discusses the roles of computers in problem solving. This is essential background information for all inservice presenters. It can also be used as a handout for workshop participants.

Section 3: Initiating/Planning an Inservice

This section offers a few suggestions to consider when beginning to plan an inservice. Novice inservice organizers will want to read this section.

Section 4: An Eight-Session Science Inservice

The inservice described in this Notebook is eight sessions of two hours each. Although the information included can be presented in eight session, there is enough material for nearly 16 sessions if desired. We suggest that you carefully read through the materials for the first session to get the general idea of the information presented.

Session 1: Hypothesis Testing Using a Computer. The session will illustrate how organizing data and electronic graphing of data can help students generate hypotheses and confirm or deny hypotheses. The main focus of the inservice sessions is on the use of computers in hypothesis testing and problem solving in science. The first session provides a basic introduction to use of a powerful microcomputer with a relatively sophisticated piece of software, Microsoft *Works*.

Session 2: Searching and Sorting Databases to Generate and Test Hypotheses. Using Microsoft *Works* we will modify a database to answer questions. The issue of when and how to use a database in the science classroom will be addressed. As in all hands-on sessions, there is more emphasis on when and why to use a computer than on specific details of the key presses needed to use a particular piece of software. Participants are expected to gain skill in actually using the computer through their computer use outside of the inservice sessions.

Session 3: Creating a Database for Testing Hypotheses. This session will illustrate how to create a database file using Microsoft *Works*. The ability to create a database opens a wide range of possibilities for integrating the computer into the science curriculum. Information on creating a database using *AppleWorks* will also be provided.

Session 4: Introduction to a Spreadsheet. Using Microsoft *Works* we will become familiar with the components and structure of a spreadsheet. Activities will demonstrate how to graph data from a spreadsheet.

Session 5: Creating a Spreadsheet. This session will illustrate how to create a spreadsheet using Microsoft *Works*. We will explore the use of a spreadsheet as a teacher and student tool. The advantages and disadvantages of using a spreadsheet as a "black box" utility will be discussed.

Session 6: Using an Integrated Package to Produce a Lab Report. This session will demonstrate how an integrated software package combines the applications discussed in the previous sessions: database, spreadsheet, and electronic graphing. A laboratory report will be constructed using information from data bases and spreadsheets.

Session 7: Investigation of Some Commercially Available Science Education Software. This session is divided into two parts: 1) the demonstration and evaluation of some commercially available databases and/or other science education software; and 2) a demonstration of using the computer as a data collection device (use of probeware). Note: The latter topic may be dropped in order to spend more time on the former topic.

Session 8: Projects and Closure. School administrators from the participant's schools will be attending. Other higher level school district administrators and the district computer coordinator will also be invited. During the last session, teams of participants will present their final projects. Each project presentation will be a maximum of *10 minutes*. It is important that these presentations be carefully prepared and accompanied by appropriate handouts. Following each project presentation, the project team will initiate a brief discussion (approximately five to ten minutes) between administrators and project participants. The theme of the discussion is what administrators can do to help teachers integrate computers into the science curriculum.

Section 5: Instruments and Evaluation

The NSF project used a variety of instruments for needs assessment, formative evaluation, and summative evaluation. Copies of these instruments and a discussion of some of the results are included in Section 5. The NSF project inservices placed considerable emphasis on formative evaluation, and we recommend that workshop leaders do likewise. Such an emphasis will help workshop leaders adjust their presentations to meet the needs of participants.

Readers are also encouraged to study Seymour Hanfling's doctorate dissertation, which was completed in the fall of 1987. Hanfling's work focused on formative evaluation of the NSF project. His dissertation was directed by Dick Rankin (the project evaluator) and Robert Sylwester. It provides substantial information about the effectiveness of the project during its first year. Additional detailed information on the long term effects of the project are discussed in Vivian Johnson's doctorate dissertation completed in summer 1988 under the direction of Dick Rankin and Dave Moursund.

EFFECTIVE INSERVICE

1.1
What the Research Literature Says

Change is difficult. It is difficult to imagine, difficult to plan for, difficult to implement, difficult to manage, and difficult to measure. Fullan (1982) states that, in the educational context, "change involves 'change in practice'" (p. 30) and he demonstrates several difficulties. For one, change is multidimensional; new materials, new teaching approaches, and alteration of beliefs must be considered.

Inservice training is a major tool in the implementation of educational change. In reporting a research-based model for such training, (Gall & Renchler 1985), the authors state, "No one yet pretends to have discovered all the elements that make staff development programs completely successful" (p. 1). One reason for this is the difficulty in designing studies that can "tease out" the effective practices from the background noise of incidental and uncontrolled effects. The most reliable measure of effectiveness—change in student behavior—is several steps removed from the major actions of most staff development programs. Joyce and Showers (1983) describe a model involving classroom-level coaching that promises to take the training all the way to the level of observation of actual classroom practice, but such designs are rarely implemented due to limitations of time and funding.

Because change takes time and is best viewed as an ongoing process, the internal state of the learners—in this case, teachers themselves—is an important consideration. Hall (1982) showed that it is desirable to match inservice to current levels of concern of the individual participants. Furthermore, continued tracking of the evolution of their level of concern can function as a diagnostic tool for modifying the content of training "on the fly," should modifications be necessary.

The literature on inservice designs that are specific to computer education is sparse. Gabel (1984) reviews the work of Isaacson (1980), Winner (1982), and Ferres (1983), and finds, that their essentially descriptive studies do not speak to the issue of effectiveness, but instead concentrate on the mechanics of developing and presenting special purpose inservice training. Gabel's own work concluded that the model suggested by Gall and Renchler (1985) was a valid and useful framework for organizing computer education inservice.

In this section, the categories for the dimensions of inservice follow those outlined by Gall and Renchler (1985) and are divided into five categories: content and organization, delivery system, organizational context, governance, and evaluation.

Inservice Dimensions

Content and Organization. The realm of the planning, development, delivery, and follow-up of actual training sessions is below the level of more global concerns such as the environment in which inservice is provided, the goals and standards of the institution whose teachers are being educated, or the measures by which the inservice program is to be evaluated. Of course, these global issues have great impact on the training to be delivered. For example, the environment may determine the resources, timing, extent and depth of the program. The goals and standards of the institution (e.g., a school district) should strongly influence (if not actually determine) the content of the program. The measures of evaluation may direct the attention of the trainers to emphasize more closely monitored elements of the program at the expense of other elements less emphasized by the evaluation instruments.

Nevertheless, the actual conduct of an inservice may be separated from these other concerns, and a large body of literature (accompanied by a much smaller body of research) is available for inspection. The predominant feature of the literature is that it is generally based upon common practice, rather than upon actual research. In fact, the *management* and *evaluation* of inservice training is more thoroughly researched than the *conduct* of inservice.

Gall and Renchler (1985) identified the dimensions of methods of delivering an inservice:

1. Readiness activities. What actions are taken prior to the conduct of training to raise teacher awareness of the importance of the inservice program? How are school leaders prepared for their roles in the training? What participant information is gathered before the program begins?

2. Instructional process. What training methods will be used to help teachers acquire the target knowledge and skills?

3. Maintenance and monitoring. What provisions are made to observe and measure the actual level of application of the content of the training to classroom practice?

4. Training site. Is the training best carried out at the school site, or is another location more appropriate?

5. Trainers. What trainer characteristics may impact the effectiveness of the training program?

6. Scheduling. What duration, spacing, and timing should the training program have?

Competently designed inservice training programs will address each of these dimensions. The usual practice of trainers is to give great attention to the instructional process, scheduling and their own preparation.

An additional question to be addressed might consider any practical distinctions that exist among different types of learners. Are adults in general (and teachers in particular) sufficiently different from other learners that exceptions or refinements must be made to the well-researched principles of learning? (see Gagné, 1977) Although the most general of these learning principles remain intact, researchers such as Knowles (1978) have determined that adult learners are sufficiently different from children as to merit distinct consideration. Among the important features of adult learners cited in Knowles' work are that:

1. Adults learn by doing; they want to be involved. Mere demonstration is usually insufficient. Practice and even coaching are highly desirable.

2. Problems and examples must be realistic and relevant to them *as adults*.

3. Adults relate their learning very strongly to what they already know. They tend to have a lower tolerance for ambiguity than children, so explicit attachment of new knowledge to their existing base is a paramount necessity.

4. Adults tend to prefer informal learning environments, which are less likely to produce tension and anxiety.

5. Changes in pace and instructional method tend to keep the interest of the adult learner high.

6. Unless the conditions of training absolutely require it, a grading system should be avoided. Checklists of criteria met in the course of training, for example, are less intimidating than the assignment of grades.

7. The instructor should frame his or her role as that of a facilitator of learning rather than as a font of knowledge or expertise. This guarantees that participants will find the trainer approachable, an absolute precondition of communication between adult learner and teacher.

It is obvious that these adult learner characteristics are of great concern to the teaching of adults and they should govern several aspects of the preparation, delivery, and follow-up. The impact of these elements of training is discussed below in summary with lessons learned from other sources.

In a study of the impact of inservice on basic skills instruction, Gall et al. (1982) identified a number of deficiencies in the ordinary conduct of inservice:

1. Programs tended to be focused on the professional goals of individual teachers rather than on the improvement of the school instructional program. Teachers' goals and school needs are not always in consonance.
2. One-shot training or short sessions failed to show impact on the school's instructional program.
3. Although the inservice programs were sponsored and financed by districts or schools, the general plan and learning activities of the training were based on goals and objectives that had little or no demonstrable connection to those of the school or district.
4. Programs were very rarely assessed on the basis of actual improvement of student performance.
5. Most inservice programs lacked several of the following desirable features: readiness activities, a meeting, follow-up activities, and in-classroom observations to identify changes in teacher behavior that might be attributed to the inservice training.

These researchers judged that programs exhibiting such deficiencies will have little impact on teacher practice or student performance.

Much of the work of Joyce and Showers (1983) centers on governance issues, but they also have critical points to make concerning the conduct of inservice:

1. Training may be considered to be composed of levels of involvement: lecture, demonstration, practice in the training environment, practice in the target environment, and coaching in the target environment.
2. Generally, lecture and demonstration have little impact in terms of changing teacher behavior.
3. Practice (following lecture and demonstration) contributes greatly to change in teacher behavior.
4. Coaching (following lecture, demonstration, and practice) not only contributes further to change, but also creates opportunities for dissemination of an innovation or desired practice throughout the unit (e.g., department, school, or school district) in which change is desired. One of the most promising of these opportunities is peer coaching.

Echoing elements of both Knowles (1978) and Joyce and Showers (1983) are some of the findings of the Florida State Department of Education (1974):

1. Inservice programs that place the teacher in an active role are more likely to accomplish their objectives than those which place the teacher in a receptive role.

2. Programs that emphasize demonstration, supervised trials and feedback are more successful than those that simply present new ideas or materials to teachers without opportunities for practice.

3. Programs in which teachers share and provide mutual assistance to each another are more likely to succeed than those that fail to encourage interaction during and after training.

4. Self-initiated and self-directed training activities (although seldom used in inservice education programs) are associated with successful accomplishment of program goals.

The literature offers many similar indicators of success or effectiveness in inservice conduct. They are briefly summarized as follows:

1. The content of inservice education programs should be directly and immediately linked to the goals of the agency sponsoring the training.

2. The characteristics of teachers as adult learners should be taken into account when inservice education activities are designed. In particular, the activities should be relevant to them as adults, new knowledge should be explicitly connected to previous knowledge, an air of informality should predominate, grading systems should be avoided, and the trainer should act as a facilitator.

3. Designs that feature multisession contact and development of an ongoing relationship between trainer and teacher is preferred over one-shot designs.

4. If possible, the training should include not only presentation of information and demonstration of new methods and skills, but also supervised practice and coaching.

Organizational Context. When referring to the organizational context in which inservice education occurs, Gall and Renchler (1985) echo the "modal systems" of Joyce and Showers (1983). While Gall and Renchler recognize the five modes identified by Joyce and his colleagues, they prefer to think of these modes as representing different functions of inservice education and go on to identify four such purposes: (a) inservice for personal professional development; (b) inservice for credentialling; (c) inservice for the purpose of induction into the profession; and (d) inservice for school improvement.

"Inservice for school improvement" speaks directly to the school as an organization. Operationally, one can define the organizational context as those organizational elements of the school that directly influence the success of inservice education. But organizational context also implies a series of interrelated components that work in relative harmony. To divorce any one component from the whole distorts our perception of and reaction to that element. Just as our perception of our environment is continuous, so the school must be viewed holistically as a continuous, dynamic collection of interlacing and interactive parts.

A meta-analysis done by Lawrence and Harrison (1980) concludes that the most effective inservice programs address the school as a unit. Their research supports the contention that inservice is most effective when the emphasis is on global goals rather than personal development.

These findings are consistent with the observation of noted anthropologist Edward T. Hall (1981) about the essential nature of the context of expression and action. He states that context determines everything about the nature of the communication and predicates further behavior. A focus on school improvement places the "situational dialect" of the teacher professional life of the teacher within the larger frame of the school as a complete unit. This broad focus of shared goals gives a context of discussion in harmony with the larger organizational context. A somewhat different but complementary observation is made by Pitken (1972) when she examines the question of social membership. She notes that with respect to learned or cultural norms, the wholeness and uniformity of our society is determined by the acquisition of like patterns by people exposed to them. These views lead again to the conclusion that the more consonant the goals are with the school, the more consistent will be the patterns of compatibility between the behavior elicited and those expressed by the administration and support staff. In essence, the new behaviors or activities must mirror the intentionality of the school as a unit.

If we place the goals of the inservice within the larger framework of the school environment and provide a collegial support structure, chances of institutionalizing any changes are improved. In a fundamental sense, the organizational context provides the ecological gestalt of action and interaction. Compatibility between the objectives of the inservice and those of the school is essential if changes are to be made a part of the taken-for-granted background of the teacher, administrators, and support staff in their daily activities.

Holly (cited in Gall & Renchler, 1985) surveyed 110 teachers and found a general preference for activities that allowed them to work with other teachers. Ngaiyaye (cited in Gall & Renchler, 1985) found that teachers preferred to work with teachers who had similar educational duties. Domain-specific knowledge as defined by Doyle (1983) consists of an explicit semantic network of relevant information and identified methods or strategies for applying that information. Although Doyle was addressing academic content, it seems clear that the same theme can be applied effectively in inservice education. Thus, not only does educational research support the need for teachers to work with teachers, but it supports a more specific domain of discourse in which they share their goals and concerns with teachers in their own or similar subject areas. In a collegial environment made up of their peers, teachers can relate common concerns and share methods or strategies central to their needs as educators (U.S. Department of Education, 1986). Furthermore, teachers with similar instructional assignments can share materials, tools, and new methods of instruction.

Unfortunately, there appears to be no research examining the relative effectiveness of variations in teacher inservice groupings as defined by Gall and Renchler (1985). Wade (1985), however, does indicate in her meta-analysis that participation by both secondary and primary school teachers is more effective than either group working alone.

In an organizational context, the school principal as an instructional leader plays a major influential role. Research by Louchs and Pratt (cited in Gall & Renchler 1985) indicates that the role taken by the principal in the implementation efforts of a program is essential to the success of the project. Leithwood and Montgomery (cited in Gall & Renchler 1985) have shown that an effective principal will participate in at least part of the inservice workshops attended by the staff. Finally, the Rand study (cited in Gall & Renchler 1985) suggests that without the approval of the principal, teachers generally will not implement a new curriculum or process.

As noted above, the school is a dynamic but loosely coupled organization. This loose coupling requires a mediating force that lends a coherence to its structure. Thus, the principal seems to act as a lens to keep school goals clearly in focus and as a guide to keep teachers on track with district objectives (U.S. Department of Education, 1986).

Governance. The issue of governance frames the larger context of school as a functioning unit. Operationally we can define governance as that organizational process of decision making that determines school policy and directs school resources. The governance of inservice education specifically addresses concerns about the way an inservice will be designed and offered to the district staff. The study by Mertens (1982) clearly shows that the view of the teacher as a professional must pervade the district; when teachers are viewed as professionals, inservice projects are more successful than when teachers are viewed merely as functionaries. All projects and or policy decisions need to be approached in this light.

There appears to be no research on the most effective infrastructure for carrying out the process of governance at the district level. However, there is ample research to indicate that this process must take into account teacher concerns and expectations. Many researchers indicate that the teacher must be given the opportunity to be part of the planning. If teachers are not consulted, the results can be disastrous. Wolcott (1977) documented a carefully planned effort for educational change in a school district in Oregon. This mammoth seven year plan involving several hundred thousand dollars, vast district resources, and uncounted hundreds of hours for both planners and teachers failed. Its primary failure was that it did not take into account the needs of the educator. It was conceived as a "top-down" approach and implemented as such.

Wolcott reaffirms the importance of teacher participation in the planning process. What is not clear is how much control teachers should have over the inservice content. On one side is the work of Schurr (cited in Gall & Renchler, 1985), where it is shown that teachers desire input into the planning process; on the other side is the work of Wade (1985) that indicates inservice sessions were gauged as "less successful" if participants were regarded as the major contributors to the process. Indeed, her meta-analysis shows that inservice sessions are more effective if the leader assumes the role of "giver of information" and teachers as "receivers of information." Clearly, a balance seems necessary. It is important to ascertain the needs of teachers so that inservice sessions can be directed specifically to their needs. On the other hand, the integrity of the inservice content must be maintained, with policy and planning decisions attempting to strike a balance between teacher input and district needs.

Another issue of governance is the recruitment of participants. Motivation to attend inservices can be subtly but definitely enhanced if the research outlined in this section is taken into account. A feeling of personal connection with the concerns of the inservice is also important. Moursund (1988) suggests that ownership in a problem-solving process is critical. Inservice by definition is a form of problem solving. If participants can feel a sense of ownership of the content of the inservice, they will want to attend and take seriously the purposes of the project.

Wade (1985) confirms the need to have a sense of ownership, pointing out that inservice is more successful when the teachers are given special recognition for their involvement. But she further reports that projects are more successful if teachers are either designated to attend or selected on a competitive basis. Clearly, the research confirms the need of teachers to be a willing part of the process, but it also indicates that directing teachers to attend is not predictive of failure. Obviously, this is a complex issue: *How* teachers are directed to attend is important; the content and relevance of the inservice is important; the organizational context is important; and the way the issue of governance has been handled in the school is historically important.

Other incentives for attending inservices described by Betz (cited in Gall & Renchler, 1985) are release time, expenses, and college credit. Administrators, however, can take heart in Wade's (1985) finding that almost any inservice can make a difference. She reports that inservice of any kind, on the average, resulted in half a standard deviation greater positive change than control groups. This is a clear indication that inservice education can influence the quality of the education.

In summary, effective inservice must take into account the school organizational context and its governance policies. It appears that the more the inservice speaks to the unifying goals of the school, the more effective will be the results.

Evaluation. As stated in Gall and Renchler (1985): "The evaluation of inservice programs is not a well-developed field," and "... systematic evaluation of inservice programs is the exception rather than the rule" (p. 30). In an effort to bring some order to the field, Gall and his colleagues (1976) attempted to define the different levels at which inservice training might have effects. They defined four levels:

Level I: Implementation of the inservice program. (Measures of the quality of the training itself.)

Level II: Teacher improvement. (Measures of actual change in teacher behavior in the classroom.)

Level III: Change in student performance. (Measures of the degree to which improvements in teacher performance lead to improvements in student achievement.)

Level IV: Changes in the environment. (Measures of changes in the school that may be indirect [or even unintended] results of the inservice program.)

The further away we get from measuring the direct delivery of training, the less certain we can be that changes in Levels II, III, and IV are actually attributable to the training program. Other factors, unpredicted and unmeasured, may have greater impact than training.

At Level I, the elements mentioned previously in the Content and Delivery System section (readiness activities, instructional process, maintenance and monitoring, training site, trainers, and scheduling) should be measured directly. In addition, some quantification of the degree of relevance of the program to teachers' perceived and actual needs should be attempted.

At Level II, the best measures are those of increased teacher competence. If the program is of novel content (as a computer inservice might well be), conventional measurements might have to be supplemented with new ones that reflect the content of the training. Observational measures of actual classroom practice are the preferred instruments.

At Level III, measures of student achievement are appropriate. Because this level is rather far removed from the training, it may be difficult to attribute changes in student behavior directly to actual inservice practices.

At Level IV, we hesitate to suggest methods of measurement. Although instruments can be created to measure school climate and levels of intercommunication among the staff (Joyce, Hersch, & McKibbin, 1983), it is perilous to presume explicit connections between an inservice program and a change in the school environment.

Conclusion

To narrow the scope of the literature on effective inservice, this review concentrates on literature dealing with the actual conduct of inservice.

The five dimensions of inservice (i.e., content, delivery system, organizational content, governance, and evaluation [Gall & Renchler, 1985]) were used to examine the literature. The predominant feature of the literature is its bases in common practice, rather than on actual research. Literature specifically related to implementing changes in educational computing is extremely limited. The literature that exists concentrates on the delivery system aspect of Gall's classification.

Currently, staff development is the major tool for implementing educational change. Reviewing the literature confirmed our intuitive belief that effective inservice is difficult to attain for the following reasons:

1. Change is multidimensional. (We are dealing with change in a school system, and a school system is a very complex entity.)
2. Change is a slow process. (It is the nature of a stable and functioning system to resist change. School systems seem to be exceptionally resistant to change, and change only slowly.)
3. Effective inservice is resource intensive. (In many settings the resources available for inservice education may not be adequate to produce a significant change.)
4. Learning styles of adults are complex. (A typical inservice will involve adults with widely varying interests, characteristics, and backgrounds.)
5. Global characteristics of school systems, many of which are outside the influence of the inservice provider, influence change.
6. Participation of teachers in the process of setting goals for inservice may enhance the learning of the participants, but it is difficult to properly achieve this participation in goal setting.
7. Mechanisms for evaluation of inservice programs are ill-defined and infrequently attempted.

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1.2

THE CI^3 MODEL FOR EFFECTIVE INSERVICE

(Note: This is a slightly modified version of a paper written by Seymour Hanfling, Judi Mathis, and Jim McCauley for presentation at the University of Oregon "Extensions of the Human Mind" conference in August 1986. These three authors were all members of the NSF CI^3 project staff when the paper was written.)

The Computer-Integrated Instruction Inservice (CI^3) project directed by Dr. David Moursund began in September 1985. The purposes of the three-year project: were (a) to develop an inservice model for educating teachers in methods of integrating general computer software tools such as databases, spreadsheets, graphics programs, science tool kits, into their curriculum; and (b) to develop a method for training inservice trainers in the use of that CI^3 model.

During the first year the project team concentrated on developing the inservice model and materials in two areas: elementary schools and secondary school mathematics. The second year of the project continued this teacher inservice development and extended it to include secondary school science. It also developed an inservice to train trainers in the use of the CI^3 model. The third year will refined the materials from the second year, created materials for secondary school social studies, and began dissemination of the results of the project.

The ultimate goal of the CI^3 project is to bring about improvement in the classroom; this is a formidable task. The process of bringing about improvement through innovation in the classroom by staff development has been studied extensively (Berman & McLaughlin, 1978; Dillon-Peterson, 1981; Fullan, 1982). Even though there is no agreement on the "one" best way to do staff development, there is agreement on the need for the support and involvement of the major components of an educational system: the teachers in a school or department, the building administration, the central administration, the school board, and the students' parents. The CI^3 project used this knowledge in formulating an inservice program.

First, we received the support of the central administration of the district within which the workshops took place. Second, we viewed the school (or department in the case of a high school) as the unit of change, not the entire district. We worked with groups of teachers from a building (or department). Finally, an administrator from each building was required to participate along with the teachers. As Wood, Thompson, and Russell (1981) point out:

> For staff development to have a lasting effect, the principal must be committed to the implementation of the inservice goals, participate in the inservice planning and activities, encourage other staff members to participate in training programs, and support and reinforce the implementation of new knowledge, skills, and strategies. (p. 63)

During the first year of the project we were quite successful in getting school administrator participation in the project. During the second and third years we were less successful. There is a substantial body of theory on how to organize and conduct an inservice to be as effective as possible. It usually turns out that there is a substantial difference between the theory and what one is actually able to accomplish. In this case, we were not able to secure school administrative participation at the level we would have liked during the second and third year.

During the first year, the CI^3 project worked with two groups of educators. One consisted of the principals and a number of elementary school teachers from three schools. The second consisted of mathematics teachers from a middle school and a high school and an administrator from each building. There were approximately 17 participants (all volunteers) per group.

Prior to the training, a needs assessment was conducted by interviewing all the participants. We acquired knowledge on a variety of topics, including the participants' current educational and personal computer usage; their access to computers, computer lab(s), and software; their views on educational uses of computers; and the areas in which they desired training.

Originally seven inservice sessions were scheduled. The sessions were conducted after school and usually at the computer lab sites of the participating schools. (Two sessions were conducted on the University of Oregon campus.) The introductory and closing sessions were originally scheduled to be five hours long (with dinner provided), and the five other sessions were to be two hours in length, held every other week. The teachers found the first five-hour session to be too long after teaching all day. We adjusted our schedule and shortened the last session to two and a half hours. As a result of this experience, we redesigned the second and third year inservices to consist of 16 hours of workshops in eight two-hour sessions.

The Inservice Model

> The wise leader knows that the true nature of events
> cannot be captured in words. So why pretend?
> Confusing jargon is one sure sign of a leader who does
> not know how things happen.
>
> *The Tao of Leadership* by John Heider

Inservice Design Principles

The participants in our inservices reflected a wide range of backgrounds and teaching environments. Although this lack of homogeneity is a common difficulty in computer-related inservice education, it led to the development of a significant premise of these workshops.

Clearly, these workshops are *not* inservice *trainings* in the sense of teaching a specific teaching technique, computer management skill or even competence with a specific piece of software, but instead are *educational* workshops. They are meant to expand teacher knowledge and capabilities in the classroom, and they provide an environment for exploring and learning about the applications of computers and software tools in the curriculum.

The issue of training versus education is critical. Computers will be part of education from now on. All teachers will eventually need to deal with computers in schools. Computer inservice for teachers needs to be an appropriate blend preparing them to make some immediate use of computers, but also laying a firm foundation for continued growth and learning in this field. It was our observation that many inservices on computers place too much emphasis on what keys to press and the specific details of particular pieces of software. Many inservices of this sort do not do a good job of developing computer-related foundational knowledge such as general roles of computers in problem solving, changes in education needed to prepare students for life in an Information Age society, etc.

The following design principles were used to create the balanced environment we deemed to be appropriate:

1. Each session should offer participants at least one idea that can be used immediately or in the short term future in their classrooms. This idea might be an activity, a piece of software, a teaching style, or a management aid. The sessions are rich learning environments in which participants discover and experience many ideas and applications of computer-related activities and software tools. These environments provide many opportunities for participants to find ideas that are appropriate and relevant to their

instructional situations. The process of discovery also helps build ownership and increases the likelihood of classroom implementation.

2. Software should always be introduced in an instructional context. Rather than training participants in the details of a piece of software, the tool is introduced with classroom examples. Activities are designed so the participants can be successful even if they have only partial knowledge of the software. This allows teachers to see that they need not understand all of the nuances of a program before they use it in the classroom. There are two reasons for this approach: First, it helps teachers explore and gain an understanding of the instructional uses of a specific software tool. Second, it provides a model for teachers to experience an activity and begin to adapt the activity to their own classrooms.

3. Participants should experience activities on two levels. First, as "students" in an inservice, are the activities meeting the objectives? What is being learned? What is being experienced? Is it enjoyable? Second, they are asked to analyze the activities and the inservice itself: What activities have been chosen? Why have those activities been selected and not others? How can those activities be adapted to their classroom?

   Reflection and discussion of these questions occurs at different times. The participants are briefly reminded to note and reflect on the first questions while they are doing an activity. These questions are then repeated during the closure discussion for an activity. The second set of questions is also discussed during closure for an activity and at the closure for the entire session.

4. The participants should work in groups. There are four reasons for this. First, Cox and Berger (1985) have shown that working in groups on the computer is more effective in solving problems than working individually. Second, the participants become accustomed to discussing computer-related curriculum matters with each another. This helps build a school level and district-wide resource base, and it builds a spirit of mutual support among the inservice participants. Third, it allows the trainers to work with more of the participants. Finally, it allows the trainers to eavesdrop on participants' conversations and gain relevant information for conducting discussions and directing the remainder of the session.

   In recent years the effectiveness of cooperative learning has become clear. Many people fear that computers will be used to isolate students and work against against the cooperative learning environment. But this need not be the case. Many computer activities can be done in a cooperative learning environment, and research supports this approach as being good.

5. Each session should be structured to allow participants to discover methods and models of instruction. The participants demonstrate or gain an understanding of these methods during the debriefing of each activity or at the session closure. This approach differs from many prevailing inservice formats by avoiding an explicit statement of inservice objectives at the outset of each session. Our goal is to avoid creating a specific mind-set in participants that may deter them from making their own original observations or restrict them from making additional observations. It also allows them to experience the activities as their students might, thus providing valuable insights that can be gained in no other way.

   Imagine, for a moment, a scale which is labeled "Pure Discovery" on one and "Pure Directed Instruction" on the other end. Most of the instruction in our schools is conducted using a style that is much closer to the Pure Directed Instruction end than to the pure Discovery end. But it is essential that both teachers and students learn to use computers in a discovery-based mode, so that they feel comfortable in working with new software applications and learning on their own. Thus, in designing the inservices, we made a decision to place major emphasis on discovery-based learning about computers. We reasoned that if teachers learned about computers in this type of mode, they would then use it with their students as they introduce computers into their classrooms.

This method requires the development of mutual trust. Through the activities the participants discover, learn, and gain insights across many pedagogical domains. During the debriefings the trainers can aid the participants in understanding and adapting their insights. This discovery and debriefing-oriented model is stimulating, interesting, and successful.

A key aspect of discovery-based learning is the debriefing periods at the end of discovery sessions. The course instructor (the facilitator) must have a clear picture of the key elements that are to be discovered. (Of course, it usually happens that many additional important elements are discovered.) The debriefing sessions allow participants to bring up and discuss the ideas that they have been working on and discovering. The facilitator must ensure that all key elements are brought up and that they receive appropriate emphasis.

6. The sessions should be *enjoyable!* There has been substantial research on the relationship between attitude and learning. We know that if participants are enjoying the learning experience, they will learn more and better.

Material Selection and Development of Activities

The main reasons that computers are so heavily used in business, government, and industry is that they are a powerful aid to problem solving and productivity. Computers can solve or help to solve a wide range of problems. The focus of this CI^3 project is to improve student problem solving by integrating of software tools (e.g.,graphics, databases, spreadsheets, science kits, etc.) into the curriculum. Thus, the theme of problem solving is interwoven throughout the design of the inservices. Inservice participants can explore and experience the use of these tools by solving problems presented in the inservices. These experiences also encourage participants to discover new ways to pose problems and even new types of problems to be solved.

Problem posing and problem solving are higher-order skills, essentially corresponding to the Analysis, Systhesis, Evaluation end of Bloom's taxonomy of cognitive skills. There is a strong and growing movement in our school system to place increased emphasis on such higher-order skills. Computers are a vehicle that can help in this endeavor.

Problem posing and problem solving are interdisciplinary skills. They are not, as many teachers think, just mathematics. All teachers should have their students pose and solve problems. All teachers should teach problem.posing and problem solving as part of their overall curriculum.

Due to the wide range of backgrounds and experiences of the participants, as well as gender differences, careful selection of materials and activities is important. However, selection of software is also limited by practical constraints. Our selections are based upon availability, quality, utility in the particular inservice situation, appropriateness to the grade and concept level, and effective cost. The last item refers to software that is under district license, in the public domain or allows multiple loading. (Some software companies give special permission for multiple loading to educators conducting teacher training.)

After the design of activities and selection of software, performance aids and learning aids (worksheets) are developed. *Performance aids* contain the basic information necessary to use a piece of software; keystroke commands, data retrieval and printer commands, for example. Many participants find that they can use unfamiliar software with a minimum of instruction if supplied with an appropriate performance aid. Participants can also learn to use some software through on-line tutorials.

Learning aids contain problems that increase in complexity and software knowledge; therefore, they may contain software comments where appropriate (e.g., how to print a graph). These worksheets range from very specific instructional sequences to open-ended explorations.

Along with performance and learning aids, sample lesson plans are provided, which can be adapted, extended, and used as models. They are important in assisting participants to transfer inservice concepts to their classrooms, and reduce the amount of effort required to develop and transfer new activities to the classroom.

Organization and Development of an Inservice Script

In organizing the sessions we tried various inservice methods and activity sequences. The ones we found successful were those that embodied our assumption that instruction is a dynamic process by nature. Decisions are made continually through the interactions of the trainers, the participants, and the content being presented. Thus, the framework of these sessions must be flexible. The same session presented with different groups of participants might begin in the same way, but then, based upon their responses and needs, proceed along different paths. Many times the participants are offered a choice of options or they are allowed to offer their own suggestions on the next step in the inservice. This dynamic process is difficult to capture in words. In the following discussion it is important for the reader to keep in mind that these inservices embody a process that is designed to be flexible.

Sequencing of Activities. The sequencing of all activities enhances concept attainment and assists in the transfer of these concepts to the classroom. The sequencing of activities begins with the most concrete activities and progresses to the more abstract.

The typical sequence for an activity is:

1. *Explore.* Allow participants time to "play," so that they may develop an intuitive understanding of the software or activity. Participants make use of a Performance Aid.

2. *Experience.* Work on the software or activities in an instructional format that models classroom presentations. Participants make use of a Learning Aid.

3. *Discuss.* Debrief the activity, paying particular attention to participants' feelings, experiences, attitudes, and ideas for instructional applications. The facilitator makes sure that key ideas that the lesson was designed to cover were indeed covered and get discussed during the debriefing. But keep in mind that the debriefing is to be conducted in a discovery based mode. The facilitator should avoid, as much as possible, switching into a directed instruction mode during the debriefing.

4. *Closure.* The facilitator gives a brief summary statement. Relate this activity to the objectives of the session or previous sessions. Integrate previous participant comments as frequently as possible during closure.

Sequencing within a session. We begin each session with a hands-on activity or an off-machine problem solving activity that is approximately 5-15 minutes long. (We strongly encouraged participants to work in pairs on the computers. Sometimes a person would decide to work alone, and sometimes three people would work together.) This instant involvement is very useful in setting the tone for the day's session. It allows participants to begin participating as soon as they arrive, and it handles the situation of some participants showing up a little late. The debriefing of this opening activity provides an opportunity to discuss the focus and general goals of the session. (A general goal might be to explore uses of computers to store and retrieve information as an aid to solving problem.)

The next 30-40 minutes is spent exploring activities on the computer with participants working in groups, generally in pairs. This exploratory period might be directed by the trainer or through performance and learning aids, with a focus on the specific objectives of the activity. Participants may become involved in trying to "solve the puzzle" or "beat the computer," and it is sometimes necessary for the trainers to draw the participants' attention to the instructional aspects of the activities. The participants may finish an activity at a later time and at their own pace.

The debriefing of all activities is extremely important. As described above, explanation and debriefing of all activities follows rather than precedes the activities. This allows participants to experience an activity in a situation without a trainer-induced "mindset" and places them in a similar position to that of their students. Encouraging participants to generate ideas contributes to the transfer of ideas from the inservice to their teaching situations. It is more likely that teachers will try new classroom practices if they have experienced these new practices in the workshops and then analyzed and reflected upon them.

The remainder of the session is spent intermixing off-computer and computer-based activities. The participants enjoy the integration of off-computer activities into the sessions. The concrete nature of these activities provides a bridge to the abstract nature of the computer.

Final closure for an entire session provides a transition from the inservice setting to the classroom. Our experience indicates that the integration of software tool activities into classes seems to take place if the integration (a) allows students to learn better, faster or in more exciting ways; (b) allows students to work with more important concepts than they are now learning; and (c) is not appreciably more difficult for the teacher than present instructional practice. Discussions during final closure are useful in generating ideas that illustrate these points.

Once the above ideas have been used in planning a session or series of sessions, it is important to review the entire set of activities. Are the transitions smooth? Are the activities building upon each other? Are the original objectives still being met? (The last question can sometimes be overlooked as "exciting" activities and software hide or even change the original objectives.) Finally, is this still a inservice that is interesting and enjoyable to lead and experience?

Inservice techniques. Like any teachers, we use a variety of techniques during the sessions. The following are those we find useful and consider the most important:

1. Model classroom activities and appropriate teacher behaviors. We generally teach the way we have been taught. The importance of modeling appropriate teacher behaviors cannot be overstated in helping participants to integrate new ideas into their classes. Merely "discussing" how activities can be done in the classroom is insufficient; they must be *experienced* in order to be understood. (Note that there is some research that suggests that elementary school teachers like to be in inservices that model appropriate behavior, and that secondary school teachers are less supportive of such an approach to inservice education.)

2. Identify and utilize participants with knowledge of the inservice contents. (No matter how carefully one states the prerequisites and describes the intent of an inservice, the participants will have widely varying backgrounds. Frequently there will be one or more participants who are quite qualified to be facilitating the inservice.) Forming groups where at least one of the participants has experience with a piece of software can help make workshops go more smoothly. Establish peer support by publicly validating participants' knowledge and encouraging peers to consult each other for answers. Remind participants that they are experienced educators who bring a multitude of skills to the inservices. (An analogous situation for teachers is using students in their class who are experienced with software to act as helpers or teachers to other students.)

3. In the debriefings and discussions, encourage participants to analyze the activities from two perspectives: that of a student (their experiences while using the software) and that of a teacher.

4. Obtain feedback from the participants at each step of the inservice. Be responsive to their needs and, when appropriate, modify the inservice plan. When necessary, help the participants reevaluate their expectations in order to gain the most from the inservice. For example, because a wide range of teacher backgrounds is present at a inservice, a specific piece of software may not fit everyone's teaching assignment. Shift the focus of those teachers toward examining the software for its strengths and weaknesses: Is it easy to use? Is the feedback appropriate? Does it allow for exploration?

5. Do not be disturbed if the time schedule that you have set occasionally requires you to interrupt participants in the middle of an activity. Research suggests that this can actually contribute significantly to learning. The interruption provides a time for participants to reflect upon their experiences during an activity.

6. Use open-ended questions that encourage teachers to reflect on the session's activities. Convergent questions can cover the content and analysis, as well as pacing and sequencing. Divergent discussions can cover transfer of the activities to the classroom and possible impact on the curriculum and individual classes. These types of questions are important and cannot be hurried. A time for reflection and analysis helps participants gain the ownership necessary to integrate new ideas into their own educational setting.

7. When the trainer does not have an answer to a question, the best response is "I don't know, let's see what all of together know about this question." There may be participants that can provide information, just as the teachers may have students in their class who can help them with a piece of software or activity.

Reference Materials, Handouts, and Log Sheets

Each participant receives a set of materials at the first session, including relevant journal articles, software reference lists, classroom ideas and public domain software. Refer participants to elements of this collection whenever related activities or discussions take place.

The participants are asked to keep a log of their computer-related activities, including: classroom lessons, work with individual students, personal use, readings and discussions with colleagues. This log form also can be used to ask trainers for information or help. The trainers respond to questions, suggest software the participants might wish to preview, and return the logs. These forms are an important feedback mechanism. It is an efficient way for participants to communicate with the trainers to have a record of their computer-related activities.

School Visits

Based on the experience from this project, classroom visits should be included as part of the inservice program. This can be done in a variety of ways: A trainer may model a lesson in a participant's classroom; both the participant and trainer may teach a class together; or the trainer may observe the participant teaching a lesson. Many teachers feel that this type of interaction is helpful.

Closing Comments

We have spent many hundreds of hours working on the CI^3 project. It has been difficult to summarize what we have learned, primarily because, as stated earlier, education is a dynamic process. The only way to learn a process is to do it. What we have presented here is a framework that has been effective. However, this is not the end of the development of an effective inservice model. Both formative and summative evaluations have taken place or are in progress; some of the results are given in Part 5 of this Notebook. As you practice using the inservice materials in this Notebook, and as you continue to practice and study the field of inservice education, you will get to be a better facilitator of inservices. One of the joys and frustrations of education is that it is constantly evolving and that educators need to be lifelong learners.

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BACKGROUND INFORMATION

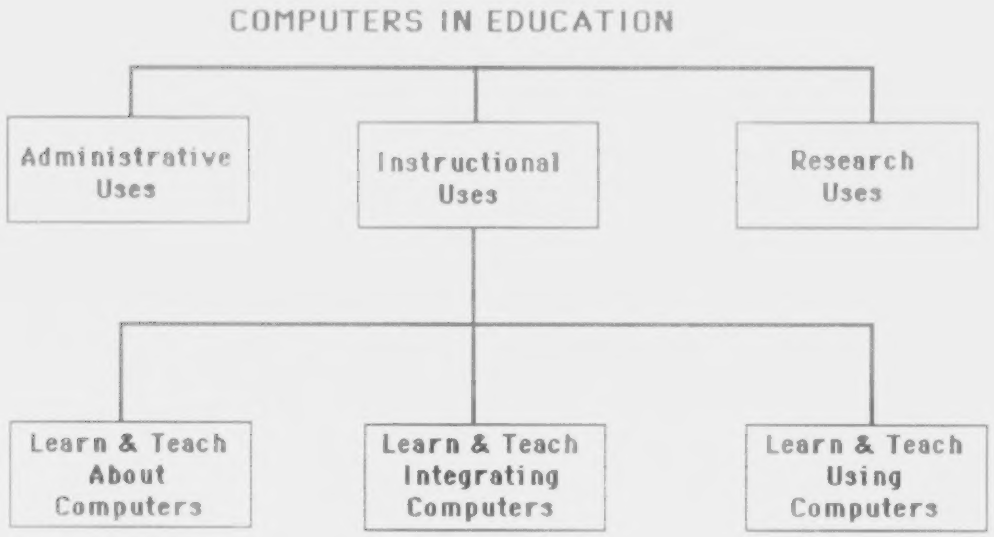
2.1
OVERVIEW OF COMPUTERS IN EDUCATION

Computers are important and widely used in our society because they are cost effective aids to problem solving in business, government, industry, education, and other areas. The primary focus of this Notebook is on the use of computers as an aid to problem solving.

This chapter of the Notebook provides an overview of computers in education, with primary emphasis on Computer-Integrated Instruction (CII). The underlying assumption is that we want to increase students' ability to make use of the computer as a tool in problem solving throughout the curriculum. This chapter might be given to inservice participants as general background reading.

Computers in Education

The diagram below presents a structure of the overall field of computers in education. As indicated in the diagram, the field of can be divided into three main parts. Although each part will be discussed briefly, the main focus is on *instructional uses* of computers. As the diagram illustrates, instructional uses of computers also may be divided into three parts. After briefly discussing each part, we will focus on *learning & teaching integrating computers*. We call this part Computer-Integrated Instruction (CII).


COMPUTERS IN EDUCATION
Administrative Uses
Instructional Uses
Research Uses
Learn & Teach About Computers
Learn & Teach Integrating Computers
Learn & Teach Using Computers

Administrative Uses

Many aspects of running a school system are similar to running a business. A school system has income and expenses. It has facilities and inventories. It has employees who must be paid and employee records that must be maintained. And, of course, a school system has students who must be taught. Detailed records must be kept on student performance, progress, and attendance.

Computers can be cost effective aids to accomplishing all of the administrative-oriented tasks listed above. Thus, it is not surprising that computers are extensively used for administrative purposes in most school districts in this country. In some school districts this use goes back more than 25 years. Overall, the administrative use of computers in schools is growing steadily.

At the current time there are two major approaches to administrative use of computers in schools. One approach is based on centralization. A large, centrally located computer system is used to serve a number of schools, as well as central school district office needs. There may be terminals to individual schools. Thus, some input and output operations may occur at the school sites. Other operations especially those involving large amounts of input and output, occur at the central facility.

An alternate approach that has gained considerable support in recent years is to place administratively oriented microcomputer systems into individual schools. Initially these were self-contained microcomputers, but there is a growing tendency to network them. It has become clear that microcomputers can make a substantial contribution to the functioning of a school office.

It seems evident that there will be a continuing need for a central, powerful computer system in most school districts. Also, it seems evident that on-site microcomputers will become increasingly popular. What is not so clear is how and to what extent the central facility and the on-site microcomputers should be networked together, nor is it always evident which computer applications are best accomplished at the school site and which are best accomplished at the central facility.

The design and implementation of a school district administrative computer system is a task for computer professionals. It takes years of computer education and experience to become well qualified at dealing with this type of task. It is important to realize the level of training and experience needed, since few computer-using teachers have this type of training and experience. In most school districts the instructional computing coordinator does not attempt to also be the administrative computing coordinator, since these positions require such different types of training and experience.

Research Uses

Educational research has benefited immensely from computers. Many educational research projects involve collecting large amounts of data and subjecting that data to careful statistical analysis. If a research project has a control group and a treatment group, students in the two groups may be tested extensively during various phases of the experiment, resulting in a substantial collection of data. Large libraries of statistical programs have been available for more than 25 years. Now such program libraries are even available on microcomputers. Thus, it is relatively easy for a researcher who is knowledgeable in the use of statistical packages to carry out a number of statistical analyses on the data collected.

Computers are making it easier to conduct longitudinal studies. Detailed records can be kept over a period of years. These records can then be analyzed, looking for patterns or trends that might not be evident under casual scrutiny. This type of research is common in medicine, and some of it has been done in education.

Computer-Assisted Learning (which will be discussed later in this chapter) provides an exciting vehicle for research. As students interact with computers while studying a particular subject, the computers can collect and maintain detailed records. These records can be analyzed to help determine which aspects of the instructional program seem to be most effective, and which need modification. Such formative evaluation can provide the foundation to improve instructional materials.

If a school district is large enough to have an evaluator on its staff, the evaluator is apt to be quite knowledgeable in research uses of computers. It is important to understand that administrative, research, and instructional uses of computers are relatively distinct fields of study. A person may be an expert in administrative uses of computers, yet have little knowledge of the statistical packages and statistical techniques of a researcher. Similarly, a person may be an expert in instructional uses of computers but have little knowledge of the hardware and software needed in an administratively oriented computer system.

Instructional Uses

Our diagram of computers in education divides instructional uses into three categories. The categories overlap to a certain extent, but it is helpful to look at each individually. The first one we will examine is **Learn & Teach About Computers.** Learn & Teach About Computers focuses on the discipline of computer science. (A very broad definition of computer science is used, which includes information science, data processing, computer engineering, etc.) This is a well established discipline; many colleges and universities have had bachelor's degrees and/or graduate degrees in these areas for more than 20 years. There are hundreds of journals and magazines that publish the rapidly growing body of computer-related research.

A few high schools began to experiment with teaching computer programming in the late 1950s. This early use of computers in schools provided solid evidence that high school students could learn to program in assembly language or Fortran. However, computers were quite expensive and not particularly accessible for use in high schools.

The development of timeshared computer systems and the language BASIC in the early 1960s opened up the possibility of large number of students learning to write computer programs. As timeshared computers decreased in price, more and more schools began to offer a course in BASIC programming.

By the early 1970s it was becoming clear that computers were beginning to transform our society. The Industrial Age had ended, and the Information Age had begun. Many educators argued that all students should become "computer literate," and that this could be best accomplished through specific computer-oriented coursework. Often the courses were in introductory BASIC programming. The trend toward students taking computer programming-oriented courses increased rapidly as microcomputers became available to schools beginning in the late 1970s.

Now a counter trend has emerged as people realize that it is not necessary to learn to write computer programs in order to make effective use of a computer. Many introductory courses have reduced their emphasis on computer programming and increased their emphasis on using applications software that use the computer as a tool. Computer literacy courses have been developed that contain little or no computer programming. Secondary school enrollments in computer programming and computer science courses have dropped markedly.

The rapid growth of applications-oriented computer literacy courses have caused a number of educational leaders to ask why such instruction must be limited to a specific course. Would it be better for students if computer applications were taught throughout the curriculum? The idea is that students should make use of the computer as a tool in all courses where appropriate. That is exactly what Computer-Integrated Instruction is about, and it is the main focus of this Notebook. CII will be discussed further later in this chapter.

The teaching of computer programming and computer science courses at the precollege level is slowly beginning to mature. A Pascal-based Advanced Placement course has been developed and is now widely taught. This has tended to lend structure to the high school computer science curriculum. However, it is evident that this type of course appeals to only a small percentage of high school students. Enrollment in introductory programming courses that use BASIC, Logo, or other non-Pascal-like languages remains high. On a nationwide basis, however, such enrollment peaked several years ago and has declined substantially since then.

Logo has developed a wide following, especially at the elementary school level. Some teachers view the learning of Logo as an end in itself. However, most Logo-oriented teachers recognize the potentials of Logo as a vehicle for illustrating and teaching various problem-solving strategies. The turtle geometry part of Logo also can be used effectively to help students learn a number of important geometric ideas. The *Logo Exchange*, a nine times per year periodical published by the

International Society for Technology in Education, is specifically designed for educators interested in using Logo in schools.

Learn & Teach Using Computers. A computer may be used as an instructional delivery device. This type of computer use is often called computer-assisted instruction, computer-based instruction, or computer-assisted learning. In this Notebook it is referred to as Computer-Assisted Learning (CAL).

CAL is sometimes divided into categories such as drill and practice, tutorials, and simulations or microworlds. Most CAL systems include a recordkeeping system, and some include an extensive diagnostic testing and management system. Thus, computer managed instruction is sometimes considered to be a part of CAL.

Initially, most CAL material was designed to supplement conventional classroom instruction. For example, elementary school students might use drill and practice mathematics materials for 10 minutes a day. But as computer hardware costs have declined and more CAL materials have been developed, there is some trend toward implementing substantial units of study and/or entire courses. Declining hardware costs make such CAL use economically feasible. For example, suppose that a small high school has only a half dozen students per year that want to take particular courses such as physics, chemistry, or advanced mathematics. It may be much more cost effective to make such courses available through CAL than through a conventional, teacher taught, mode.

CAL has been heavily researched over the past 30 years. The evidence strongly supports the educational value of using CAL in a wide variety of settings. The success of CAL may be explained by three factors. First, students using CAL on the average spend more time on task. Because learning correlates well with time on task, students on the average learn faster using CAL. Second, CAL materials allow students to work at their own levels and at their own rates. This individualization is a considerable aid to some students. Third, CAL materials can incorporate good practices of instructional and learning theory. Formative evaluation can provide a basis for improving CAL materials under development. Through this approach, the quality of commercially available CAL materials is gradually being improved.

Learn & Teach Integrating Computers. The third category of instructional use of computers is Computer-Integrated Instruction (CII). CII focuses on the computer as a productivity tool, an aid to problem solving. One orientation focuses on general purpose or generic application packages such as database, graphics, spreadsheet, word processor, and telecommunications. Each of these application packages is widely used in business, industry, and government. In education, each can be used at a variety of grade levels and in a variety of courses.

A second orientation focuses on the development of applications software for a specific discipline. For example, there is now a substantial amount of software that can help a person compose music. Such software makes possible the teaching of musical composition to elementary school students. There is a substantial amount of Computer-Assisted Design (CAD) and other graphics artists software. Such software tools are often now centrally used in high school courses that used to focus on drafting or engineering drawing.

It has long been recognized that precollege students could learn to use computers as an aid to problem solving. The initial approach, now dating back more than 25 years, was to have students learn to write computer programs to solve specific categories of problems. For example, it was suggested that if a math student could write a computer program to solve quadratic equations, this indicated real understanding of that mathematical topic. Over the years there have been a number of research studies on whether this is indeed correct. While the results have been mixed, it seems clear that having students write computer programs to solve math problems is not a magical solution to the problems of mathematics education that our schools face.

Initially, such an approach to CII made little progress because both the programming languages and the computer hardware were not suited to the needs of most precollege students. But the advent of timeshared computing and BASIC have helped to change that. And then, beginning in the late 1970s, microcomputers, with built-in BASIC, made it feasible for millions of students to learn to write simple programs to solve specific categories of problems.

It takes considerable time, as well as a specific type of talent, however, to become a competent computer programmer. It was soon recognized that the time was being taken away from the study of conventional subject matter. The movement toward integrating computer programming into various high school courses has long since peaked and has been replaced by a trend toward using applications packages. This new trend has accelerated as better applications packages have become available for microcomputers used in schools. An increasing percentage of this software is specifically designed for use in education.

Word processing can be used to illustrate both the general idea of CII and some inherent associated difficulties. Word processing is a generic computer application tool in the sense that it is applicable across the entire curriculum at all grade levels. Clearly, a word processor is a cost effective productivity tool for secretaries and for many people who do a lot of writing. Moreover, word processors make it easier to do process writing (prewrite, compose, conference, revise, and publish). For these reasons, many schools have decided to have all their students learn to do process writing in a word processing environment.

But it takes quite a bit of instruction to learn to make effective use of a word processor. To learn proper keyboarding techniques and to keyboard faster than one can handwrite takes a typical fourth grade student about 30 minutes a day for eight weeks or more. To learn to compose at a keyboard and make effective use of a word processor takes additional instruction and practice.

There are several additional difficulties. First, teachers have to learn to provide the initial instruction and to work with students who do process writing in a word processing environment. Even if the initial instruction is provided by a specialist rather than the regular classroom teacher, the classroom teacher must work with students after the initial instruction. All of the students' subsequent teachers face the same problem. This suggests that large numbers of teachers will need to learn to work with the idea of process writing in a word processing environment.

Second, there is the matter of access to appropriate computer systems. Once a student becomes adept at this mode of writing, the student will want to continue its regular use. This can easily require providing each student with 30 minutes of computer time per day. It also raises the issue of needing to provide computer access for students to use at home, after school, and on weekends.

Third, there is the problem of testing—especially standardized testing. Suppose a student has had several years' experience in using a word processor to do process writing. The student has learned to approach writing projects using this productivity tool. There is a good chance the student can write better and faster using a word processor than using pencil and paper. An appropriate assessment of this student's writing skills requires giving the student access to a computer during the test.

Fourth, once one has a word processor, it is quite helpful to have a spell checker, a grammar/style checker, and an outliner. Such aids to writing may have a significant impact on the nature of the writing curriculum. They may require changes in textbooks, lesson plans, and the way class time is structured. And once again the issue of testing arises. Should a student be allowed to use spelling and grammar checkers when doing writing for an essay test?

These four types of difficulty occur for all CII applications. The problem of teacher training is addressed specifically by the materials in this notebook. The problem of access to appropriate hardware and software will be with us for many years to come. It can be overcome through appropriate allocations of money. The testing problem is being addressed by a number of agencies involved in widespread assessment. For example, some states and provinces now allow use of calculators on certain tests. However, it seems clear that this will be a long term problem. Textbook companies are slowly beginning to address the issue of integrating the computer as a tool into the books they publish. School districts and individual teachers interested in making more rapid progress are developing their own curriculum materials.

The Potential of CII

Many work environments now provide a computer or computer terminal for every employee. It is clear that this will become more and more common, since computers are such useful aids to solving certain types of problems and increasing human productivity. Thus, it seems appropriate to assume that increasing numbers of today's students will use computers when they go to work.

Research on transfer of learning strongly supports the position that instruction and training should closely parallel the final desired behaviors. Thus, if we need workers who are adept at using computers to aid in solving problems, we should integrate computer use as students develop their basic problem-solving skills and strategies. For these and other reasons, it seems clear that CII will grow rapidly for many years to come.

As CII increases, both teachers and students will begin to question the content of many of their courses. If a computer can solve or help solve a particular type of problem, what should students learn about the problem? Is it necessary and appropriate to learn to solve each type of problem using only conventional aids such as books, and pencil and paper? Or, should schools focus more on underlying concepts and help students gain an overall understanding of problems that computers can solve?

In some cases an answer will be forced on schools. For example, libraries are being computerized. Card catalogues are being replaced by computerized information retrieval systems. Important publications are available only in computer databases. Since learning to access information is an essential component of education, students will have to learn to use databases and computerized information retrieval systems.

In other cases schools will have wide options. For example, consider the impact that handheld calculators have had on the upper elementary school and middle school mathematics curriculum. While the potential for calculator-integrated instruction is large, the actual impact on the curriculum has been minimal. This is true in spite of many years of strong support from the National Council of Teachers of Mathematics for integration of calculators into the curriculum. In April 1986, the NCTM issued still another strong statement recommending calculator use at all grade levels. A few states and provinces are now beginning to allow use of calculators in certain testing situations. We may be seeing the beginnings of a trend toward allowing calculators (and, eventually, computers) in standardized testing situations. During the academic year 1987-88, for example, the Chicago public schools purchased approximately a hundred thousand calculators for use by their students.

Much of the short term potential for CII depends on how well our educational system addresses the issue of inservice education. All current teachers can learn to make effective use of CII. Given appropriate inservice educational opportunities, many will do so.

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2.2
ROLES OF COMPUTERS IN PROBLEM SOLVING

Each academic discipline focuses on certain types of problems. Each discipline has vocabulary and notation, methodology, and tools to aid in describing and solving its problems. Problem solving is a unifying theme throughout all of education. In this chapter we use the term problem solving in a very general sense, so that ideas such as higher order skills and thinking skills are also included.

Undoubtedly the single most important idea in problem solving is that of building on the previous experiences of oneself and others. For example, consider the importance of language in problem solving. The language(s) you speak and read have been developing over many years, beginning long before you were born. You learned to speak and read many years ago, so that now when you speak or read you are using learning work that you did long ago as well as building on new meanings words have taken on for you.

Paper and pencil provides another type of example of building on the previous work of oneself and others. It is evident that paper and pencil are useful aids to problem solving in every discipline. Paper and pencils artifacts developed and produced by people. When you use these artifacts, you are building on the work of the inventors, producers, and distributors of these artifacts. Paper and pencils are tools that you spent many hours learning to use when you were young. You now use them readily and with little conscious thought of your earlier learning efforts.

The Computer Tool

Now we have a new, general purpose aid to problem solving. (Actually, the electronic digital computer was invented in the 1940s, so it really isn't very "new" anymore. Commercial mass production of computers began in 1951 with the introduction of the UNIVAC I. Most people who talk about the computer being a new tool are people who have been introduced to computers relatively recently. The computer is new to them, so they assume it is new to others.) The advent of the microcomputer beginning in the mid-1970s has made computers readily available to very large numbers of students and workers. However, it is only recently that enough computers have been made available to precollege students to begin making an impact on their education. In that sense, computers are still a new tool in education.

One of the most important ideas in problem solving is that the aids available for solving a problem shape the thinking processes used. You have grown up with books and pencil and paper. When you were a young student, you received many years of instruction in their use. Now, when working on a problem, you automatically consider possible uses of these aids.

For example, suppose that you needed to prepare lesson plans for a course. Perhaps you would first do some brainstorming, writing notes to yourself on the major ideas to be covered, sources of information, time lines, and so forth. Next, you might go to your files and pull out materials you have collected and/or used in the past. Then you might begin to organize, writing new materials and adding to old materials. Perhaps a trip to your bookshelf or the library might be necessary. Finally, you might put it all together in a notebook or in file folders.

This description represents a problem-solving process. It involves careful thinking, drawing on one's knowledge of students, one's own teaching skills, the teaching/learning process, school schedules, etc. It involves creating new materials and reorganizing old materials. It involves information retrieval, organization, processing, and storage. In this problem-solving process you automatically and with little conscious thought make use of reading and writing. The reading/writing tools, which are actually essential to solving the problem, are essentially transparent in the problem solving process. That is, you don't even think about them. Eventually it will be this way with computers, and that is a major goal for computers in education.

A computer can be a useful aid in accomplishing much of the work in solving the lesson planning problem discussed above. However, relatively few people have worked with computers long enough for computer use to be second nature. Indeed, it could well be that most adults today will never achieve this level of comfort or ease in using computers. But students who have the ability to learn reading and writing can also learn how to use the computer as a problem solving tool. This can be done through computer-integrated instruction which focuses heavily on the computer as an aid to problem solving.

Because computers are still rather scarce in elementary schools, the idea that students may grow up accustomed to the idea of using the computer as a tool may seem rather "far out" to you. But on a national scale we are now in a period of very rapid growth in availability of computers in schools. The value of learning to use a computer with a word processor, spelling checker, and grammar checker is now widely accepted by educational leaders. Many school districts have made the decision that all their students should have such an educational opportunity. Often these school districts are also teaching their students to make use of databases and computer graphics. Eventually these types of problem solving tools will be a routine part of the elementary school environment as well.

A Definition of a Formal Problem

Every person encounters and copes with a large number of problems every day. Many of these problems are routine and solving them becomes almost automatic. But think for a moment about the variety of problems you deal with in a typical day on the job. For example, as a classroom teacher, you routinely solve problems such as deciding what materials to teach, how to present them to students, how to measure student performance, and how to work with students who are not performing up to your expectations. You attend staff meetings and work on problems faced by the whole school. You handle your personal budget, solving problems on how these funds should be used. It is easy to extend the list, and you should find little difficulty in building your own list. This exercise should convince you that you are an accomplished problem solver and know a great deal about problem solving.

Problem solving has been carefully studied by many great thinkers. There are a number of books that define the concept we call *problem* and explore a variety of problem-solving techniques. (see the references listed at the end of this chapter). We will use the following four components as a definition of problem:

1. **Givens**. There is a given initial situation. This is a description of what things are known or how things are at the beginning.

2. **Goal.** There is a desired final situation (or more than one). This is a description of how one wants things to be; it is a description of the desired outcome.

3. **Guidelines.** This is a listing or description of the general types of steps, operations, or activities that may be used in moving from the Givens to the Goal. Guidelines are the resources and facilities—that is, the powers of the problem solver. (The Guidelines *do not* tell one how to solve the problem.)

4. **Ownership.** In order for something to be a problem for you, you must accept some ownership. You must be interested in solving the problem or agree to work on the problem.

The choice of vocabulary (Givens, Goal, Guidelines) is for the mnemonic value of the three G's. Other writers may use different terms. When we say that a problem is *well defined*, we mean that the three G's are clearly and carefully specified. A well-defined problem can be worked on by people throughout the world over a period of time. Progress toward solving the problem can be shared, and cumulative progress is possible. This idea of sharing progress toward solving a problem or category of problems is absolutely fundamental to the human race making intellectual progress.

We frequently encounter problem-like situations that have some, but not all, of the four defining characteristics of a formal problem. We will call these *problem situations*. Often the most important step in solving a so-called "problem" is to recognize that it is actually a problem situation and then do the work necessary to obtain a carefully defined problem. This requires careful thinking, drawing on whatever knowledge one has that might pertain to the problem situation. Often a group of people will have a brainstorming session to get relevant ideas. See especially the works by Torrance. His research and development group has produced instructional material designed to help students gain improved problem-solving skills. See also de Bono (1971, 1973).

Each of the four components may require further explanation in order to become clear to you. We begin with the last one: Ownership. Some experts on problem solving exclude this component, while others give it considerable weight. If coping with a particular situation is essential to your survival, you are apt to have considerable ownership of this situation. But if the situation is a hypothetical (school book) exercise of little intrinsic interest, you may have little or no ownership. Ownership is a mental state, so it can quickly change.

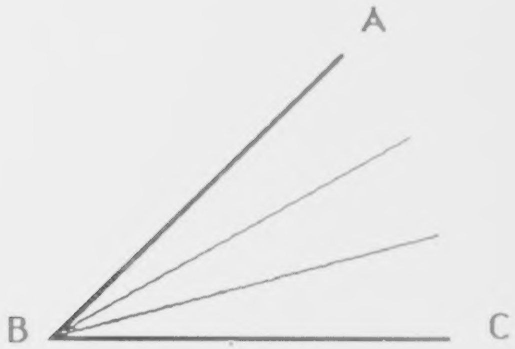
The issue of ownership is particularly perplexing to educators. They recognize that ownership—that is, a deep interest and involvement with a situation—often contributes to deep and lasting learning and intellectual growth. Thus, teachers often expend considerable effort creating situations in which their students will feel ownership.

Some alternatives to ownership are apathy and/or coercion. Keep in mind that problem solving is a higher order mental activity. Most people do not perform higher order mental activities well under coercion or while in a "I couldn't care less" mood.

As an aside, you may know some students who have spent literally dozens or even hundreds of hours working on a particular computer program or mastering a computer system. You may have said to yourself, "If only I could get all of my students that deeply involved." It is clear that such ownership of a computer-related problem has changed the lives of a number of very bright and talented students.

Many people are puzzled at first, by the Guidelines component of the definition of problem. Suppose that you were giving your students a spelling test. From the student viewpoint, the task of correctly spelling a word is a problem to be solved. The student would be successful if allowed to use crib notes or a dictionary. What makes the problem a challenge is that these aids, and other aids such as the use of a neighboring student's paper, are not allowed. The Guidelines specify that students are to do their own work, without the use of crib notes or a dictionary.

For the mathematically oriented reader, another excellent example is provided by the problem situation of trisecting an arbitrary angle. In the figure below, angle ABC is an arbitrary angle (i.e., it is of unspecified size). The goal is to do a geometric construction that divides angle ABC into three equal angles.



Given angle ABC

Sometimes the Guidelines specify that one is only allowed to use a straight edge, compass, and pencil. In that case it can be proven mathematically that the problem cannot be solved. In other cases one is allowed to use a protractor in addition to the other implements. Then the problem is easily solved by measuring the angle, dividing the number of degrees by three, and constructing new angles of the resulting number of degrees. Note that in the latter case the compass is not used, even though it is available. Solving real world problems is sometimes difficult because many resources are available, and often it is not clear which ones to use to solve a particular problem.

For a third example, consider this problem: Teachers in a particular school seem to be using substantial amounts of pirated software. You can investigate the problem situation to clarify the given situation (that pirated software is being used by teachers). You can set a goal, such as reducing the use of pirated software by two-thirds in the first year and decreasing it still more the second year. As a responsible and ethical educational leader, you may have considerable ownership of the problem situation. But what are the guidelines? What types of things can you do that might help achieve the goals?

Brainstorming, individually or in groups, is often used to develop a list of resources (guidelines) or potential activities you might carry out to solve a problem. For example, teacher software piracy might be reduced by an informational program, providing money to buy enough software, threats of dismissal, and so forth. Further exploration would be needed to determine if these options were actually available to the problem solver.

Steps in Problem Solving

In this section we list a sequence of steps that may be followed in attempting to resolve a problem situation. Often we carry out some of the steps quite automatically with little conscious thought. But it can be quite helpful to consciously think about each step in problem situations that seem to be giving us trouble. (Here we are assuming the Ownership condition is satisfied; that is, you are interested in resolving the problem situation.)

1. Work with the problem situation until you have converted it into a well-defined problem; that is, until you have identified and understood the Givens, Goal, and Guidelines. This first step is a creative, higher order thinking process, which often involve considerable knowledge as well as a good sense of values. Two different people, when faced by the same problem situation, may come up with quite different well-defined problems.

2. Select and/or develop a procedure that is designed to solve the problem you have defined. This is an information retrieval and/or creative thinking step. Usually it involves both; computers may be useful in retrieving needed information. (We will discuss the idea of *procedure* more in the next section of this Chapter.)

3. Execute or cause to be executed the steps of the procedure. Sometimes this will be a mechanical, nonthinking activity, where speed and accuracy are desired and computers may be quite useful. (The executions of many mathematical procedures falls into this category.) At other times the execution of a procedure will require the best of truly human skills. (The work of a good psychotherapist falls into this category.)

4. Examine the results produced in Step 3, to determine if the problem you defined in Step 1 has been solved. If it has been solved, go on to Step 5. Otherwise, do one of the following:

   a. Return to Step 3 and recheck your work. People and machines sometimes make mistakes.

   b. Return to Step 2 and determine another approach to solving the problem you have defined.

c. Return to Step 1 and determine another problem to be solved.

d. Give up, or seek help from others. The problem might not be solvable, or it might be beyond your abilities, or it might be beyond the efforts you are willing to make at this time.

5. Examine the results produced in Step 3 to determine if the original problem situation has been satisfactorily resolved. If it has, you are done. If it hasn't, do one of the following:

   a. Go to Step 1 and determine another problem to be solved.

   b. Give up, or seek help from others.

Problem solving research suggests that students benefit from learning and practicing the above five-step approach to problem solving. It is applicable over a wide range of disciplines and problem-solving situations. Notice that success is not guaranteed, but that persistence increases the likelihood of success. Note also the personal nature of the five-step approach. Problem solving is a personal thing, and personal values are often central to a problem situation.

What is an Effective Procedure?

When you are able to solve a particular type of problem routinely or automatically, you have developed one or more procedures (algorithms, detailed sets of directions, recipes) for this type of problem. Computer scientists are deeply concerned with developing procedures that tell a computer how to solve a certain category of problem. We will use the phrase *effective procedure* in discussing the idea of a procedure that can be carried out in an automatic, nonthinking, computer-like mode.

More formally, an effective procedure is a detailed, step-by-step set of instructions having the two characteristics:

1. It is designed to solve a specific problem or category of problems.

2. It can be mechanically interpreted and carried out by a specified agent. Here the term "mechanically interpreted" means in a machine-like, nonthinking manner. Computer scientists are interested in situations where the agent is a computer or a computerized machine such as a robot.

Computers are important because they can rapidly, accurately, and inexpensively execute many different procedures. The number of such procedures continues to grow very rapidly through the work of researchers in all disciplines, computer scientists, and computer programmers. Thus, an understanding of the concept of effective procedure is generally considered to be an important part of computer literacy, and it certainly lies at the heart of having a general understanding of roles of computers in problem solving.

Roles of Computers

In this section we briefly examine each of the five steps one might follow in resolving a problem situation. Our intent is to point out roles of computers in each step and to briefly discuss possible curricular implications.

The first step is to understand the problem situation and work toward having a well-defined problem. This is a thinking step , drawing on one's general knowledge as well as specific information about the problem situation. That is, both a broad general education and in-depth knowledge about the specific situation are useful. Many educational leaders argue that a broad liberal arts education is useful in understanding and critically examining the wide range of problem situations one encounters in our society. Values education plays an important role here because the process of developing a well-defined problem from a problem situation often depends heavily on personal values and views.

Computer-Assisted Learning (CAL) is of growing importance in acquiring education for understanding problem situations. Research evidence strongly supports the contention that students generally learn faster in a CAL environment than they do in a conventional instructional environment. There is strong research evidence that CAL is a cost effective aid to students. The evidence is strongest in the acquisition of factual knowledge, or at the lower-order level of Bloom's taxonomy. Computerized drill and practice works!

The second step is to select and/or develop a solution procedure for the well-defined problem you have produced in the first step. You might select and retrieve a solution procedure from your head.

As an example, the problem might be to determine the number of cubic yards of concrete needed for a patio that is to be 12 feet wide, 15 feet long, and 4 inches thick. A procedure to solve this problem involves conversion of units, multiplication, and division.

S1: Convert 4 inches to feet (by dividing it by 12).

S2: Multiply the three dimensions (each given in feet) to find the number of cubic feet in the patio.

S3: Divide the answer produced in Step 2 by 27, to convert it to cubic yards.

It is important to realize that there can be many different procedures for solving a problem. Here is another approach to solve the patio problem:

S1: Convert all measurements to yards. This involves dividing the measurements given in feet by 3, and dividing the measurements given in inches by 36.

S2: Multiply the three dimensions (each given in yards) to get the number of cubic yards of concrete needed for the patio.

The mental selection and/or development of a solution procedure is a thinking process. One can gain skill in this thinking process through practice. Computers can be used to create practice situations. Many simulations or simulation/games are designed to provide practice in this problem solving step.

An alternative to retrieving a procedure from your head is to retrieve it from a library, which may contain books, periodicals, films, and so forth. Many libraries have replaced their card catalogs by computerized card catalogs. Moreover, much of the information needed is now stored in computers. One of the defining characteristics of the Information Era we are now in is the growing availability of information and the growing technology to aid in information retrieval. It is clear that computers are very important in retrieving procedures for solving problems. This strongly suggests that all students should learn to make use of these aids to information retrieval.

The third general step in resolving a problem situation is to execute or cause to be executed the procedure from the second step. As we have indicated, some procedures require a "human touch." Others can be executed mechanically, in a nonthinking fashion. A large and rapidly growing number of procedures can be executed by computers or computerized machinery.

If a computer can execute or help execute a procedure, what aspects of this procedure do we want people to learn to do mentally, assisted by pencil and paper, assisted by noncomputerized machinery, or assisted by computerized machinery? This is a very difficult question, and it will challenge our educational system for many years to come. The answer that seems likely to be widely accepted is that we want students to have a reasonable understanding of the problem being solved and the capabilities/limitations of the computerized procedure. We want students to remain in control, but we want them to work with computers rather than in competition with computers.

The fourth and fifth steps in resolving a problem situation require examining the results of your work to determine if you have succeeded. These steps require critical thinking, drawing on your understanding of the initial problem situation and the steps followed in resolving the situation. These are higher-order mental activities.

The research literature on problem solving strongly supports the idea that people get better at problem solving if they study the processes of problem solving, learn to use aids to problem solving, and practice problem solving. This suggests that students should learn to use computers as an aid to problem solving in disciplines for which computers are an useful aid. They should practice solving problems, making use of computers when their use is appropriate to the problems being solved.

Software

In a broad sense, all computer software can be considered as problem solving software. But when we think of preparing teachers and/or students to deal with computers in schools, problem solving software tends to fall into three main categories:

1. Programming languages such as assembler, BASIC, C, COBOL, Logo, Pascal and Pilot.
2. Application packages, such as a graphics, spreadsheet, or database package. Some application packages are useful across many disciplines, so we call them "generic." Others are useful in quite limited contexts (such as software for writing music).
3. Simulations/games specifically designed to help students learn specific problem solving techniques.

There are hundreds of programming languages. In all cases the intent is to make it possible for a human to communicate with a computer. Usually a programming language is designed to meet the needs of a particular category of computer programmers. For example, BASIC was originally designed for college students, COBOL was designed for business data-processing programmers, and Pilot was designed for writing Computer-Assisted Instruction materials.

In all cases one uses a programming language to specify procedures to solve certain categories of problems. This is a very important concept. The writing of a computer program to solve a problem requires both a knowledge of a specific programming language and skill in developing procedures to solve problems. The latter is called *procedural thinking* and is generally considered to be an important component of computer literacy. Skill in procedural thinking is independent of any particular programming language. Indeed, one can develop a high level of procedural thinking skill independently of whether computers are available or whether computer programming is used to represent the procedures.

Computer-in-education leaders have not reached consensus as to which students should receive instruction in computer programming, at what grade levels, or using which particular programming language(s). For example, many school systems have decided to provide instruction in Logo to all of their elementary school students. Other districts have decided to include some BASIC in a junior high or middle school computer literacy course required of all students. Still other school districts have decided that computer programming is best left as an elective course, perhaps mainly available to secondary school students who have had a reasonably strong mathematics preparation.

Applications software may be generic (useful over a wide range of disciplines or problem areas) or it may be quite specific to the problems in a particular discipline. A computer graphics package is useful over a wide range of disciplines, while music composition software has much more limited applicability. A trend has begun to emerge, and it seems likely to continue. Many school districts have decided that all students should learn to use a variety of generic applications software. The use of such software will be integrated into the total curriculum. Initial instruction may be in a variety of courses at a variety of grade levels, or it may be concentrated into a single computer literacy course.

At the same time there is growing realization that each discipline has its own applications software. Thus, as students study a discipline at a higher and higher level, they need to receive specific instruction in use of the applications software of the discipline. Thus, two types of computer literacy are emerging. A computer literate student uses generic computer applications software as appropriate in working with problems in every academic area. As a student progresses to higher levels or greater depths in any particular discipline, the student becomes more and more computer literate within that specific discipline.

For example, a student who takes college preparation courses in chemistry and physics should be learning quite a bit about applications software specific to the fields of chemistry and physics. Microcomputer-based laboratory (MBL) software falls into this category.

There are many general purpose problem-solving techniques. For example:

1. Plan ahead, anticipating the consequences of proposed actions.
2. A large, complex problem can often be solved by breaking it into several smaller, less complex problems.
3. It is often helpful to draw a picture or map, or in some other manner graphically represent the problem under consideration.
4. It is often helpful to write down the steps you take in an attempt to solve a problem.

Many different simulation/games software packages have been developed to give students practice in particular problem solving techniques. Research into the value of such software is sparse. The main difficulty seems to be the issue of transfer of learning. For a particular simulation/game, it is evident that students get better as they practice using the software. That is, they get better at applying particular techniques in the context of the simulation/game under consideration. But there appears to be relatively little transfer of the techniques to other problem solving situations. It seems likely that the teacher plays a very important role in helping to increase such transfer of learning. A teacher can provide a wide variety of examples, suitable to the academic level and interests of a particular student, where the techniques are applicable. A teacher can help encourage students to apply the problem solving techniques they have studied to the variety of problems they encounter throughout the school day.

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INITIATING/PLANNING AN INSERVICE

3.1

Preliminary Planning and Activities

This section consists of some general ideas followed by the project staff in setting up the workshops. Although some of the ideas are useful primarily to people who are working in a relatively formal environment such as a funded project, others apply to any inservice activity.

Many inservices are open to all educators in a district or region, perhaps subject only to certain prerequisites. But research on effective inservice points to the value of peer support within a school or department. Thus, there is considerable merit in having a number of participants from a single school. The NSF project set guidelines of having at least 3 - 5 or more participants from each school, including a school administrator. While it was not always possible to adhere to these guidelines, they served as an aid in the participant screening process.

Needs Assessment

The starting point for planning an inservice is to determine the need(s) that will be addressed by the inservice. (That is, what educational problem is being attacked through the inservice?) Chapter 1.1 discusses some of the needs that an inservice might address. The question is, how are needs determined?

Ideally, a school district would have a carefully developed long-range plan for instructional use of computers. Detailed information on the development of such a plan is given in Moursund and Ricketts (1988). The appropriate development of such a long-range plan involves participation by all of the stake holders. Thus, teachers, school administrators, parents, etc. all have ample opportunity to provide input.

A long-range plan calls for certain actions to be taken. Generally, these actions will include acquisition of computer facilities, acquisition or development of software, courseware, and curriculum materials, and *staff development*. That is, the process of developing a long-range plan can play a major role in doing a needs assessment for a computer inservice. One merely points to the long-range plan and says "We need to do this particular inservice because of the key role it plays in implementation of the plan."

There are, of course, other approaches to needs assessment. And even if one has a well done long-range plan, these other approaches are useful and should be followed. Generally speaking, a needs assessment should be done using both a bottom up and a top down approach. The bottom up approach is to obtain information from the people who are to be inserviced. The top down approach is to obtain information from the administrators of the people who are to be inserviced. Such information can be obtained by personal interviews, use of questionnaires, informal conversations, etc. Part 5 of this Notebook contains some needs assessment instrumentation.

The needs assessment will answer a variety of questions such as:

1. What are the demographics of the group of potential participants in the inservice?
2. What level of interest is displayed by the group of possible participants?
3. What are suitable meeting times, places, length of sessions, and number of sessions for the potential participants?
4. What incentives, such as college credit, release time, improved access to computers in their schools and classrooms, etc. are needed to secure there will be an appropriate number of participants?
5. What is the level of support from the administrators of the potential participants? Does this level of support include release time for teachers, appropriate materials, appropriate staff support to develop and conduct the inservice, etc? Does it include making appropriate computer facilities available to the participants in their schools and classrooms during and after the inservice? Does it include actually participating in some or all of the inservice sessions themselves?

Staffing

Most people who organize and present inservices are trained and experienced teachers. But facilitating an inservice is quite a bit different from teaching a class of precollege or college students. Also, the inservice participants will all be educators themselves. Educators expect that the inservices they participate in will be models of excellence. They are not very tolerant of poor organization and teaching. Most teachers find that teaching teachers is much more difficult than teaching other groups of students.

We have two recommendations. First, don't attempt to do a hands-on inservice (such as discussed in this Notebook) without an assistant. Your assistant may be someone you are helping to train as an inservice facilitator or a computer coordinator from one of the schools participating in the inservice. Once participants get into a hands-on mode, there will be many more questions than a single facilitator can handle. Of course, having participants work in pairs will help some. Emphasize that participants are to work quite hard to discover the answers to their questions before they seek help from the workshop facilitator or assistant.

Second, plan to spend at least 8 - 12 hours preparing for each two-hour inservice. Many teachers are used to planning a whole day's teaching in an hour or so. But a staff development workshop is quite different. Here you will be working with your peers, and you want to do an excellent job. Here also you are doing something new—you have not offered the workshop a number of times before. *It will take a lot of hard work to be adequately prepared to facilitate the workshop sessions.*

Some Initial Ideas

Let's assume you have decided to conduct an inservice and that you have a general topic and audience in mind. You do a needs assessment and conclude both that you will be able to obtain appropriate participants and that you will have appropriate administrative support. You have a staff (it might be only a part-time secretary, a volunteer, or members of a district computer committee) who will be involved in the overall planning and implementation process. You have selected an assistant who will help during the inservice presentations. You have a good idea of how the inservice will contribute to accomplishing the district's overall plans for computers in education.

The following list of ideas may help you as you continue the planning and development of the inservice.

1. Meet with your staff early and often. Have them participate in the overall planning process as much as possible. This helps to keep them informed (so they can respond to telephone inquires when you are not available, for example) and increases their "ownership" in the overall task.

2. Establish guidelines for selecting the schools and individuals who will participate. Check these guidelines with the funding agency or group responsible for making the inservice possible. If you are not the computer coordinator for the region to receive inservice, check with the computer coordinator.

3. Communicate with the potential participating schools and individuals. This may be done via a combination of mail (regular and electronic), announcements in newsletters, phone calls, and direct contact. Indicate generally the desired nature of school and individual participants, and indicate where and when an information meeting will be held.

4. Prepare for and conduct the information meeting. You will want to have a handout containing key information that possible individual and school participants need to know, which may include appropriate application forms. Hold the informational meeting early, so that possible participants from each school will have time to have an in-school meeting to decide if they will participate.

5. If you are giving university credit to the participants, make sure you have everything coordinated with the university or college as well as the school district(s). This process can take some time, so begin early.

6. Your inservice will use of a variety of software. You will need multiple copies and/or permission from publishers to do multiple loading. Make sure that you begin the process of obtaining the software and/or permissions early enough so that this task is completed well before the inservice is scheduled to begin.

   The choice of software can be a major decision. Should you use software readily available to teachers, or should you use the "latest and greatest"? An inservice must be grounded in reality. Thus, much of the software used should be software to which teachers have easy access. But an inservice should also be forward looking. Thus, it is appropriate to use some software that may be new to teachers in your school or district.

   To a large extent, the NSF project used software from the Minnesota Educational Computing Consortium (MECC). This was done because such software is in wide use throughout North America and because it was available in the school district where the inservices were being conducted. However, we also obtained multiple copies of some software on loan from certain vendors, and we obtained permission to do multiple loading from certain other vendors. Our experience was that vendors are very supportive of staff development efforts.

7. Your inservice may make use of print materials that will need to be ordered from publishing companies or reproduced. It can easily take a month to obtain print materials from a publishing company, begin this process well in advance of the starting date for your inservice.

8. Think about where and when the inservices are to be conducted. From the point of view of the inservice organizer, it is easiest to conduct all inservices at one central site, and to hold them at a time that "seems" convenient to the organizer. However, participants may gain more ownership and overall involvement if the inservices are conducted in their schools.

This involves holding inservices at a number of different sites with varying equipment facilities. It involves holding inservices at a time that the potential participants have indicated fits their needs.

Miscellaneous Suggestions to Inservice Facilitators

1. At the first meeting of the inservice, be well organized. Have name tags available, appropriate refreshments, etc. Be efficient and business-like. If appropriate, provide each participant with a list of the names, addresses, and phone numbers of the participants and the facilitators.

2. At the first meeting of the inservice you will most likely want to have a number of things to hand out. These might include:

    a. A notebook for participants to keep materials in, with colored paper or dividers to separate the lessons.

    b. The types of materials illustrated in this Notebook. (Some inservice facilitators prefer to hand out all materials during the first session, while others prefer to hand out each session's materials at the start of that session.)

    c. Other print materials, such as books, that participants will need during the inservice.

    d. Some software, if it is appropriate. For example, there may be some excellent public domain software that is suitable for participants in the inservice. Participants like to receive free materials.

    e. A syllabus for the inservice.

3. Much of the material you hand out may be forms that you want participants to write on during the inservices. If so, make sure participants know that extra copies of these pages in the handout can be "ordered" from you so that they feel free to write on them during the sessions. Have a form available to them, so they can order copies as needed, or just provide them extra copies in an automatic fashion.

4. The computer is a powerful tool and a powerful change agent in education. Both the overall educational system and individual educators are (in general) resistant to change. The inservice facilitator should deal openly with change processes and resistance to change. This should be a reoccurring theme in the debriefing at the end of each activity. Spend some time thinking about educational change. How do you feel in your role as a facilitator of change?

5. Student/teacher modes. The style of inservice described in this Notebook has the participants sometimes play the role of "students" and other times play the role of "teachers." Make the participants aware that at times they will be students and at other times teachers during the inservice sessions, and why the inservice is designed in this way. This switching of modes can be confusing, so make it clear when you are having participants switch roles.

6. The style of inservice described in this Notebook is heavily oriented toward discovery based learning. Be aware that relatively few teachers are comfortable with discovery based learning. Think about why discovery based learning is particularly appropriate in computer education and in this inservice. Raise this as a topic for discussion quite early in the inservice, and raise it several additional times during later inservice sessions.

7. Transfer of learning is a very important idea in computer inservices. The goal is that participants will take ideas from the inservice and implement them in their classrooms. Raise this as a topic for discussion during the first inservice session and bring it up again at subsequent sessions. It is quite appropriate to ask in the second and subsequent sessions "Would one of you please share with us some classroom uses you made this week of the ideas that we covered in the last session?" Do everything you can to encourage such immediate implementation and the sharing of successful implementations.

8. Keep in mind that problem solving is a central and unifying theme in the inservice and is the main reason why computers are coming into schools.

    a. The computer-as-a-tool is essentially the computer as an aid to problem solving. Problem solving should be a central theme in every activity and in every debriefing.

    b. Many of the changes that may occur as computers come into schools are changes that could/should occur even without computers. A typical example is increased emphasis on problem solving in math and decreased emphasis on rote computation. Another example is increased emphasis on the overall writing process (process writing) and less emphasis on the mechanics of writing, such as spelling and grammar.

9. Preparation time. (Here we are repeating some ideas given earlier in this chapter, because they are particularly important.) The novice inservice facilitator may wonder how much work is involved in preparing to facilitate a sequence of inservice sessions. Of course, a lot depends on the standards the person sets. Also, the time depends heavily on the overall knowledge of computers, computers in education, the subject discipline of the teachers to be trained, and the software to be used. The experiences of the NSF graduate assistants who did almost all of the presentations during this project have shown that even a highly qualified inservice facilitator can easily spend 8 - 12 hours preparing for a two-hour inservice. (*Note: It doesn't take nearly this long to prepare for subsequent presentations of the same inservice.*) Access to materials such as those in this Notebook can decrease preparation time somewhat and can add to the overall quality of an inservice. But to a very large extent, the quality of an inservice depends on the quality, experience, and preparation of the facilitator.

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3.2

Sample Timeline Outline

The final format of the NSF inservice sessions discussed in this Notebook was a sequence of two hour sessions. The sessions were held immediately after school, typically from 3:30 - 5:30 or 4:00 - 6:00 in the afternoon, one day per week.

Through careful thought, trial and error, and experience, we gradually developed a Sample Timeline for the organization of a two hour session. In essence, this Sample Timeline consists of a model for a one hour session, and the model is followed twice for a two hour session. This way of building longer sessions from a one hour session can be further extended to still longer inservice sessions.

The outline given below suggests specific amounts of time for the various parts of an inservice session. However, flexibility is important. The actual time spent on any given activity will depend on the activity, the facilitator, and the participants.

Minutes allotted	Activity
10	*Starting activity*. Have participants either work on an off machine activity or on the computers with software that is fairly self-explanatory. Make use of an appropriate Performance Aid.
5	Debriefing of the above activity.
25-35	*First major activity for the session*. This is time for the participants to be on the computer. It can be a more in-depth continuation of the starting activity, or it can be a new piece of software.
10-15	Debriefing of the above activity.
10	A short break for stretching, coffee, cookies, other refreshments, and informal conversations. Generally speaking, there is never enough time to accomplish the aims of an inservice program. Don't let the break time stretch too much!
30-35	*Second major activity*. Again, participants will be using the computer in most such activities. However, sometimes off machine activities are quite appropriate.
10-15	Debriefing of the second major activity.
10	*Closure*. Summarize what was accomplished during the day; any additional comments from the participants or yourself; details of the next meeting.

This general outline is only meant to serve as a starting point for organizing a two-hour session. There may be certain sessions where the debriefing and discussion is of more importance than hands-on time. In those cases the facilitator should adjust the schedule as necessary. In other cases an off-machine activity may be more appropriate than a hands-on activity.

A key concept in the CI^3 model is a discovery-oriented approach. Most inservice facilitators are quite used to delivering lectures that cover a given body of material. But the amount of straight lecture time in a two-hour session such as outlined above should probably be less than ten minutes!

Rather than lecture, the inservice facilitator facilitates. Participants spend the bulk of their time in two modes. The first is a hands-on mode, usually working in groups of two at a machine. This is a learn-by-doing environment. Participants are encouraged to answer their own questions by a combination of trial and error, reading the Performance Aids and other handouts, and asking each other. When the inservice facilitator must intervene, it should be as a facilitator rather than as an answer provider.

The second major participant mode is group discussion, sometimes in small groups and sometimes in a whole-class group. Many teachers have had relatively little experience in facilitating small-group and large-group discussions. (A good way to gain experience is by working with a group of educators. This is because once a facilitator gets educators started talking, it is hard to get them to stop!) A good rule of thumb is that the facilitator should talk less than half of the time during a group discussion.

The group discussion debriefing sessions must lead to discovery or reiteration of the major points covered. Thus, the facilitator must have these points in mind. As participants make comments that relate to the major points, the facilitator must seize these opportunities to make sure that these points have been discovered and comprehended by all participants. Initially, many inservice facilitators find that this is harder to do than to just delivering a straight lecture. But, with practice, it becomes an enjoyable and relatively easy mode of instruction.

EIGHT-SESSION SCIENCE INSERVICE

4.1

Session1: Hypothesis Testing Using a Computer

4.1.1 Narrative Overview

Introduction to the Computer-Integrated Instruction Inservice Science Sessions

This section of the Notebook contains more than enough material for eight two-hour inservice sessions for secondary school science teachers. The material presented here is the outcome of a substantial amount of planning effort and has been pilot tested twice. The first pilot test led to major changes. The second pilot test suggested some additional changes. The materials given here will provide you with a good starting point for developing an effective science inservice to meet the needs of your science teachers. That is its intent. It is not intended to be an inservice that can be picked up and used without thought.

All the materials developed for this Notebook demonstrate an instructional strategy emphasizing generation and testing of hypotheses using generic (that is, general purpose) computer applications (database, graphing, spreadsheet, word processing). Take a look at Figure 1 on the next page. It summarizes the science skills that science educators focus on in the classes they teach. Notice the central role of generating and testing hypotheses.

To a great extent, these inservice materials are intended for use in a "hands-on" environment. However, quite a bit of the inservice time was spent in discussions ("debriefings") of the hands-on activities. Each computer application was introduced to participants in the following manner: (a) demonstrate an instructional strategy in a highly structured manner, (b) break down the strategy to demonstrate prerequisite skills, and (c) allow the participants time to learn the application in the context of the instructional strategy.

The CI^3 inservice model recommends the following organization for a two hour session. Start with an activity. Hands-on computer activities were extremely successful in pilot studies. Follow the activity with a debriefing, and then have a 10 minute break. Following the break, debrief the Game of the Week. The rest of the session, concentrate on the second major hands-on activity and its debriefing. During each debriefing, make explicit the instructional strategy demonstrated. Encourage participants to discuss why they would choose or not choose to use the instructional strategy in the science classroom. During the discussion, point out as often as possible how generic computer applications facilitate instructional strategies that incorporate process skills (organization of data, interpretation of data, observational skills, generating and testing of hypotheses).

The CI^3 project decision to develop materials using an integrated software package on the Macintosh microcomputer allowed us to demonstrate the full power of software tools. The fact that the materials in this Notebook are Macintosh based may require you to modify materials to conform to local hardware and software resources.

Feedback from our pilot studies suggests additional modifications: (a) increasing the number of sessions devoted to each application, (b) increasing the time allocated for each session activity, (c) demonstrating how to use each application in a large group mode (one computer with large screen display), (d) including time for participants to develop one complete lesson for each application and to demonstrate the lesson to the inservice participants. That is, the National Science Foundation development and pilot testing of the eight sessions given in this Notebook indicate that they contain far too much material for the time that was allocated to them. The inservice would be improved by either covering only part of the materials in this Notebook or extending the length of the inservice.

The materials in this Notebook were designed and developed with the knowledge that integration of computers into the science curriculum is a difficult and lengthy process. Research suggests that teachers with positive attitudes towards computers are more willing to use them than teachers who have poor attitudes toward computers. To maximize the development of positive attitudes in our inservice participants, all activities were designed to provide practice in a small set of skills the project assumed the participants would value (refer to Figure 1). Pilot studies validated our assumption. It is our belief that teachers are more likely to devote the time and energy necessary to learn a complex technology if they believe it will be valuable to their students.

Science Skills

Communication of Results

Data Collection

Data Organization

- diagram
- chart form
- picture

Generating and Testing Hypotheses

Interpretation of Data

- charts/diagrams
- graphs
- calculations

Observation

Figure 1: Process Skills Emphasized in CI^3 Science Activities

Overview of Session 1

Session 1 is designed to: (a) help participants and staff become acquainted with one another, (b) conduct an informal needs assessment if a formal one has not been possible, and (c) introduce participants to the philosophy of the CI^3 inservice model and materials. The design of this first session reduces the time participants spend in a hands-on mode. Please note that this is the only session where hands-on activities *are not* the primary component.

The time allocated for becoming acquainted is variable and is based on the trainer's judgment of the relationship he/she has established with participants. If you feel that a congenial and comfortable professional relationship exists, reduce the time. However, if you are unfamiliar with the participants or have not conducted a formal needs assessment, allocate one quarter of the first session to getting acquainted.

Why spend a quarter of the first session getting acquainted? Unless you have conducted a needs assessment prior to the inservice, it is difficult to accurately judge the perceptions and expectations of the participants. This information is important because participant objectives influence their reactions to the inservice. If participant objectives are different from yours (frequently the case with computer inservice), address the issue immediately. This helps create an atmosphere where participants accept a wait-and-see attitude before making judgments (either positive or negative) about the goals of the inservice. Remember, integrating computers into the curriculum requires substantial investments of teacher time and effort, and the immediate benefits are not always apparent. Teachers, staff development personnel, and administrators must have a strong long term commitment to educational computing to make it through the adoption and implementation stages.

Inservice participants highly value the personal contacts they make during inservice sessions. They often build personal contacts that provide collegiality and intellectual support that lasts long after most of the content of the inservice is forgotton. Thus, it is important to provide time and an appropriate environment so that participants can get to know each other quite well.

One approach to facilitate getting acquainted is the use of an informal needs assessment. It takes time, but is recommended even if a formal needs assessment has been conducted. The procedure is simple. Have participants pair up with someone they do not know. Instruct the participants to take two or three minutes to introduce themselves, including the reasons they are attending the inservice. Inform participants that following the introduction period, they will introduce their partner to the rest of the group. As the introductions take place, list on the board or the overhead the reasons for attending the inservice. Use the list to point out individuals with similar objectives. This information is valuable for the following reasons: (a) it encourages the formation of peer groups outside of the inservice, (b) it can be used as data in a needs assessment for planning future inservice, and (c) it provides descriptive baseline data regarding teacher perceptions, necessary to measure behavioral changes during follow-up evaluation.

The CI^3 inservice model stresses using teachers' previous knowledge and linking computer activities to skills participants already value. Use the Science Skills handout during the first debriefing period to facilitate this type of linkage. Pilot testing of this handout has validated that science teachers believe the ability to organize and graph data, generate hypotheses, and develop strategies to test hypotheses, increase the likelihood that a student will achieve success in science. Research indicates that when teachers believe a teaching strategy has the potential to increase student achievement, they are more likely to use it. The major goal of Session 1 is to develop positive teacher attitudes toward using database software to teach students how to organize and graph data to generate and test hypotheses.

Activity 1 and 2 (Organizing and Graphing Data to Answer Questions Part I and II) illustrate how reorganizing and graphing data can be used to test hypotheses. Participants in both pilot studies confirmed that students spent little classroom time practicing these process skills. The debrief of Activity 1 should open with this point. In a supportive fashion, have teachers explain why they do not engage in this type of instruction. (Of course, the participants in your inservice may be the exception, and thus already engaged in the desirable style of teaching.) List the difficulties on the board. Encourage teachers to discuss how computers, databases, and activities such as the one demonstrated provide teachers with new tools that can eliminate some of the difficulties listed.

Session 1 activities also demonstrate how to introduce teachers (and later on students) to a delivery system (the computer and database program) and a potentially uncomfortable teaching strategy (guided discovery). To reduce anxiety, the activities are highly structured and concentrate only on demonstrating hypothesis testing using a computer and database program. The activities are *not designed* to teach participants mastery of database or computer related skills. This is a key idea. The amount of inservice class time is not adequate for participants to master the software. In addition, it is essential to spend a great deal of this time discussing classroom applications and implications of the computer software. The inservice class time is adequate to get participants started in using the software, but they will gain mastery of it only through a great deal of work on their own outside the inservice meeting times.

The Performance Aids (Organizing and Graphing Data Part I and II) are designed to move participants (with little or no computer experience) through the activities with as little difficulty as possible. As participant comfort level and confidence increase, the design of database activities changes. The activities become less structured and more open ended, and are designed to provide participants with practice in specific database operations (searching and sorting).

End the debriefing session by discussing why the structured activity model is an appropriate way for introducing students to the concept of generating and testing hypotheses using a computer and database program. Remind teachers that their students may not feel comfortable with this learning environment. One major barrier to educational change through inservice education is that students themselves often actively resist change. The teacher implementing new ideas into the classroom must be prepared to deal with this resistance.

Students are used to a system of instruction where typically there is one correct answer. Introducing Computer Integrated Instruction (CII) activities necessitates creating an atmosphere with these characteristics: (a) teacher and student work in a cooperative relationship, (b) students are encouraged to be risk takers, and (c) the process of arriving at an answer is valued more than the correct answer. Structured activities are designed to develop participant (and later on student) comfort in this new instructional setting.

Teacher/student access to computers varies with the school district, so the session ends with an off-computer activity demonstrating how to reorganize and graph data to generate and test hypotheses. Brainstorm with teachers to identify additional off-computer activities that can be used to introduce database concepts, provide practice organizing data to test hypotheses, and as activities for some students while the rest work at the computers.

The Game of the Week is an open ended off-computer activity. It is designed to accomplish two objectives. One, it demonstrates how organizing and graphing a collection of data can be used to generate and help confirm or deny hypotheses. This type of instruction is the most powerful use of either a chart or electronic database in the science classroom. Two, The Game of the Week demonstrates how teachers can provide students practice using a database operation such as sorting when computers are limited. This type of activity can be used by half the class while the others are engaged at the computers.

A recommended modification of Session 1 is to require participants to write a lesson plan using the activities demonstrated. This may help you to detect teachers who are likely to use databases only to look up information. This is a common problem. People frequently use a new tool, in this case the database, in a manner similar to the one it replaces, in this case a chart. In a supportive manner, make explicit the importance of using the power of the new tool to accomplish new objectives. In summary, if the objective is to look up information,.use a chart. However, if the objective is to develop student mastery in reorganizing and graphing data to identify patterns or trends, help confirm or deny hypotheses, and generate new hypotheses, use a computer and database program.

4.1.2 Script

Theme

Reorganizing data to generate hypotheses and using electronic graphing to test hypotheses.

Objectives

1. Develop positive teacher attitudes toward using database software to teach how to organize and graph data to generate and test hypotheses.
2. Illustrate graphing capabilities of a computer as a teacher tool.
3. Use visual representation of numeric data to confirm or deny hypothesis.
4. Help participants and staff become acquainted with one another.
5. Familiarize participants with the philosophy of the CI^3 inservice model and materials.

Materials

Software	***Hardware***
Microsoft *Works* Program disks	One Macintosh per two participants
Microsoft *Works* Data disks	800k external drives or hard disks
	Several printers

Handouts

Participant Objectives
Activity 1: Organizing and Graphing Data to Answer Questions Part I
Science Skills
Activity 2: Organizing and Graphing Data to Answer Questions Part II
Session Descriptions
Glossary
Quickstart Ready Reference Guide to *FrEdWriter*
Game of the Week
Participant Log

Resources

overhead projector
overhead markers
Science Skill transparency
notebooks
name tags
refreshments

Setup

Prior to participants' arrival set out the following
- participant notebooks
- name tags

Intro
5 minutes

As participant's arrive, have them pick up their name tag and notebook. Instruct participants to open the notebook to page 1 and complete the Participant Objective Sheet. The Participant Objective Sheet becomes part of the formal evaluation of the inservice. Collect these before going on to Activity 1.

Activity 1
20 minutes

Purpose: Using a Computer to Generate and Test Hypotheses is designed to: 1) introduce teachers to a delivery system composed of a computer and a database program, 2) demonstrate how to use a computer to reorganize and graph data to generate and test hypotheses, 3) familiarize participants with the operation of the Macintosh interface, and 4) demonstrate a process approach to science using the computer.

Activity 1 is an example of a performance aid. Performance aids are detailed step by step instruction sheets. The performance aid is written so that participants with no experience using a computer or the software program can complete a specific task. Activity 1 is not designed to help participants develop mastery in using a database or electronic graphing.

Activity 1 instructs participants to: 1) select a hypotheses to describe a relationship between two fields of data, 2) visually inspect graphs of the relationship to confirm or deny the hypothesis they selected, and 3) write down two or three sentences on why they would choose to use this type of activity in their classroom.

Debrief
30 minutes

Introduce the members of the training and evaluation team. Provide a short resume for each member to establish their credibility with participants.

Have participants work in groups of 2 or 3 to complete the Science Skills Sheet. Participants will identify and write down the skills required by students to achieve success in science. Allow no more than 5 minutes for this process. Ask participants to share the results of this exercise. Be patient; allow a 7 second response time before calling on someone. Using an overhead projector, compile a list of the skills they identify. Continue with this process until someone identifies:

- data organization
- hypothesis testing

Use this list of skills as the basis of the debriefing. Start by having participants name the skills that were incorporated in Activity 1. Ask participants to verbally describe how they currently provide students with classroom practice of these skills. Encourage participants to name advantages database activities similar to Activity 1 have over current instructional methods in providing students practice in generating and testing hypotheses. The purpose of the debriefing is to help participants recognize that Activity 1 is a modification of what they already teach or would like to teach.

Note: The purpose of the activity is not to have participants become proficient with the operation of the computer or the software. Keep the debrief centered on the theme of using different arrangements of data to answer questions.

Break
10 minutes

Make sure that all computers are shut down before the start of Activity 2.

Activity 2
25 minutes

Purpose: The objective of Organizing and Graphing Data to Generate and Test Hypotheses is to provide participants practice confirming or denying hypotheses by examining graphs of the relationships.

The activity can also be used as a starting point to discuss the use of the computer as a black box graphing device.

Debrief
10 minutes

What insights did participants have about using graphs to confirm or deny hypotheses? What other topics are appropriate for hypothesis testing? What is their reaction to the "black box" approach?

Other discussion topics
- facilitation of hypothesis testing in classroom
- impact of computer as a tool on science curriculum
- limitations of graphing capabilities of Microsoft *Works*
- distortion of data using graphs
- need for careful evaluation of computer tools

Closure
20 minutes

(This is an exceptionally long closure)
Purpose: To wrap up this session.
Discuss the format of the session.
Explain the sequence of future sessions.
Prepare teachers for their roles in planning and sharing what they have learned with others in their school. Ask permission to circulate participant names, address, and phone numbers. Explain the "Game of the Week" and final project.

Game of Week

One copy of the fish database is attached to the Game of the Week question, and participants can make additional copies. Instruct participants to take some time and examine the database. Have the participants generate two or three questions not addressed during Session 1 that could be answered by comparing different fields of the database. Suggest that they think about reordering these fields in ascending and descending order.

This exercise might be easier to visualize if participants actually cut up the fields of the data base and physically manipulate them. Encourage participants to do this. When they have their questions, request they paste the fields in the arrangement necessary to answer their specific questions.

Final Project

(Discuss if the last session is devoted to participant projects.) The last session will be one to let individuals or groups present their projects. The ideas are left to the participants. They can be for their classroom, planning a scope and sequence that can be used across several grades, or inservice ideas for their own staffs — sharing at faculty meetings or with specific teachers, etc. Provide examples from previous inservices.

Weekly Log

The logs are to be filled out each week.
The reason for the log is to help participants keep track of their own actions.
Examples of the type of information to keep track of:
- software they used or previewed;
- non-computer activities (activities that can also be used as computer activities later) they have used;
- teachers they have shared information with;
- development of project ideas;
- questions of the presenters.

The log can serve as their note-taking device for future reference.

Closing Groups: If there is time, let teachers from a school form groups. Their task will be to begin to discuss what they can do to help people in their school.
- What are the needs at their school?
- How can information best be shared?
- This is not a time to complain, but a time to be pragmatic and look at how things can be improved. Teachers may wish to begin discussing project ideas that could involve school curriculum.

Omit if time is a problem

What did you enjoy?

- What one idea will you take back to your school and try?
- What will you share? It does not have to be a computer idea; it could be a non-computer activity.
- What did you gain from working in groups?
- How do you set up groups when you use computers with students?

Non-computer activities are as important as computer activities.

- How might you modify today's to use with your students?

Were a variety of auditory, visual and kinesthetic avenues used in today's session?

No matter what their computer knowledge, teachers have valuable skills and ideas that are relevant to using computers in science. Have them share these thoughts and suggestions.

These inservices are structured to work with groups of teachers from a school or department. The purpose is to build a support group of people who can work and share ideas with others in their school.

Describe the sequence (or content) of future sessions.

Bye-Bye

Make the teachers aware of the large number of things they have covered in the short period of time of the inservice such as:

- operation of Mac
- booting software
- basic operation of database program
- science applications.

Encourage them to incubate ideas.

Thank them for their participation.

Think Ahead

Remind everyone:

- Fill out the logs
- Where the next meeting will take place
- Discuss who will provide refreshments if not done by the presenters.

Evaluation Indicators

- Did they have fun?
- Did they find one idea to take back with them?
  It does not have to be a computer idea; it can
  be a non-computer activity.
- Did they work in pairs?
- Was the desired behavior modeled?
- Did you vary the auditory, visual, and kinesthetic input?
- Did you give them respect for the valuable skills and knowledge they brought with them to the computer?

4.1.3 Timeline

Generally, there is far more material discussed in each Script then can be adequately covered during a two hour session. Also, the Script provides more detail than the inservice facilitator will want to be reading during the actual facilitation. Thus, we provide a Timeline, in essence an abbreviated script or lesson plan, that represents one possible organization of an actual session.

Before participants arrive, have the Microsoft *Works* Program Disk and the Data Disk at each computer. As participants enter they will pick up a name tag and notebook. Instruct participants to open the notebook, complete the Participant Objective and return to the instructor.

0:00 - 0:05
5 min

As participants arrive have them complete the following:

- Name, address, school and home phone, etc. for sharing
- Participant Objective sheet

The Participant Objective sheet is part of the formal evaluation. Participants will write one or two sentences to describe what they hope to accomplish as a result of completing the the inservice. Collect these as participants complete them.

0:05 - 0:25
20 min

Participants working in pairs will complete Activity 1. Suggest that each pair include an experienced and inexperienced computer user. At the end of the activity make sure the computers are shut down, but not turned off. Activity 1 requires participants to:

- select a hypothesis to describe a relationship
- look at graphs of the relationship to confirm or deny the hypothesis they selected
- write down 2 or 3 sentences on why they would choose to use this type of activity in their classroom

0:25 - 0:55
30 min

Introduce the trainers and evaluation team.
Provide a short resume on each member to establish credibility with the participants.

Have participants work in groups to complete the Science Skills Sheet. Participants will identify and write down the skills required by students to achieve success in science. Compile a list of the skills they identify. Continue listing skills until participants identify:

- data organization
- hypothesis testing

The purpose of the Science Skills sheet is to help participants recognize that Activity 1 is a modification of what they already do. Use these skills as the basis of the debrief. Have teachers:

- name the science skills required by students for success in science that were incorporated in Activity 1
- describe verbally how they currently provide students with in-class practice of the skills incorporated in Activity 1
- name the advantages database activities have over their current instructional methods in providing students in-class practice of these skills

Be prepared to address the pros and cons of allowing students to use electronic graphing tools and other technological aids.

0:55 - 1:05
10 min

Break. Make sure that all computers are shut down before the start of Activity 2.

1:05 - 1:30
25 min

Participants working in groups will complete Activity 2. Each group will load the Microsoft *Works* Program disk and the Data disk. Groups will:

- select hypotheses to describe relationships
- visually examine graphs of the relationships to confirm or deny the hypothesis they selected

If time permits, help participants print out the graphs used in Activity 1 and Activity 2.

1:30 - 1:40
10 min

Debrief Activity 2: What happened? What did participants discover by completing the activity? The debrief should cover:

- how database and electronic graphing can to be used as an instructional aid for students to practice hypotheses testing in the classroom
- issues associated with the "black box" approach to graphing
- the impact of generic computer applications on the science curriculum
- limitations of electronic graphing
- misrepresentation using graphs
- best fit curve

1:40 - 2:00
20 min

Closure: Discuss the following

- Game of the Week
- Weekly Logs
- final projects; handout explanation sheet
- meeting place for session 2
- 1 hour of open lab time following each session
- access to trainer outside of inservice meeting time hours

4.1.4 Handouts

These handouts are needed during Session 1. The facilitator may want to make some of these into overhead projector foils for use during the inservice.

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Organizing and Graphing Data to Answer Question:
Part I

Note: These directions are for Microsoft *Works* Version 1.0.

1. Turning on the computer.

   - Reach behind the left side of the Macintosh and flip the power switch.

   A picture of a disk with a flashing question mark should appear on the screen.

2. Inserting the disks.

   Hold the disk with the label up and with the metal tab facing away from you.

   - Insert the Microsoft *Works* Program disk into the slot (internal drive) in the front of the machine.

   - Insert the Microsoft *Works* Data disk into the disk drive (external drive) to one side of the computer.

   The **mini-finder** screen (large box on the left of screen) will display the following message: **MiniFinder Icons not installed on disk...**

   Use the mouse to move the arrow (**cursor**) over the **Drive** box.

   - Press the button on the mouse and release it. This action is know as **clicking.**

   The mini-finder screen displays the following five pictures (**Icons**): **Microsoft Wo..., Mammal File..., Fish Files, Explore Spr..., Kinematics, Explore Data, and Energy Balance**.

3. Selecting the desktop.

   - Use the mouse to move the arrow (**cursor**) over the **Fish Files icon.**

   - Press the button on the mouse and release it. A square appears around the icon, indicating that the icon has been **selected**.

4. Opening a file.

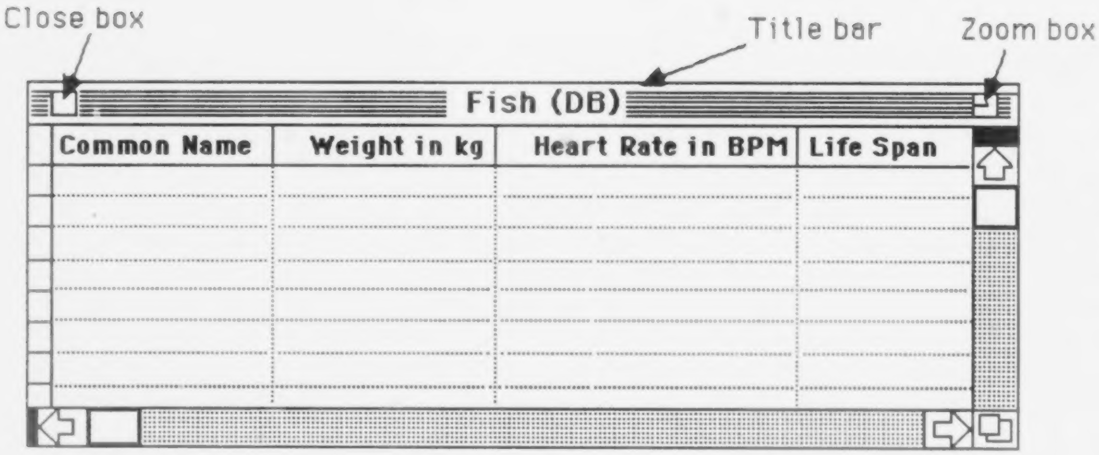
   - Move the cursor over the **OPEN** box.

   - **Click** the mouse (press the mouse button once).

   This **opens** the Fish File.

   Three windows appear on the desktop: **Fish (DB), Fish--Life Span (SS), Fish--Heart Rate (SS)**.

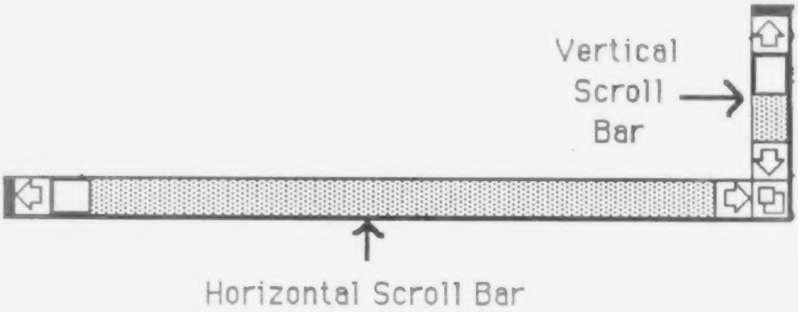
   - Place the cursor within the **title bar** (refer to the diagram below) of the **Fish (DB)**. This action **selects** the Fish data base.



Common Name	Weight in kg	Heart Rate in BPM	Life Span

- **Click** the mouse button on the zoom box (press the mouse button down and quickly release it while the cursor is in the zoom box). This action opens the file to the full window.

To view data beyond the boundaries of the window, use the horizontal and vertical scroll bars. The horizontal scroll bar is at the bottom of the window. The vertical scroll bar is at the right of the window.



5. Using the scroll bars.

The scroll bars can be moved by clicking on the arrows at the end of each scroll bar.

- Click on the right arrow to move the window to the right.
- Continue clicking the right arrow until you see the last data base **field** (Number of Chromosomes).
- Count the number of **fields** (or categories) included in this data base.

Return the horizontal scroll bar to its original position.

- Click on the left arrow to move the window to the left.
- Continue clicking until the scroll bar is in its original position.

6. Use the down arrow to move the vertical scroll bar.

   - Click on the down arrow to move the window down.
   - Count the number fish records in the data base.

   Notice that the **Weight in kg** field is arranged from smallest to largest. Does arranging the data in this manner suggest a relationship between a) the life span and weight of a fish and b) the heart rate and the weight of a fish?

7. Put a check next to the hypothesis that best describes the following:

   I. The relationship between the life span and the weight of fish.

   - The life span of a fish *lengthens* as the weight of the fish *increases*.
   - The life span of a fish *lengthens* as the weight of the fish *decreases*.
   - The weight of fish has *no effect* on the life span of fish.

   Put a check next to the hypothesis that best describes the following:

   II. The relationship between the heart rate and weight of fish.

   - The heart rate of a fish *increases* as the weight of the fish *increases*.
   - The heart rate of a fish *decreases* as the weight of the fish *increases*.
   - The weight of fish has *no effect* on the heart rate of fish.

8. A graphic representation of the data might help confirm or deny your hypothesis. Several graphs using the data from the fish database have been prepared.

   To view the first example:

   - Point the cursor to the word **Window** in the **menu** bar.
   - Pull down the **Window** options by holding down the mouse button.
   - Move the **cursor** down until **Fish--Life Span (SS)** is highlighted, then release the mouse button.

   The small window displaying the **Fish--Life Span (SS)** will appear on top of the **Fish (DB)** full window.

   - Click on the zoom box to get a full window view.
   - Point the cursor to the **Chart** options.

- Select the **Draw Chart...**option. The **Fish--Wt vs. Life** chart will be selected (highlighted).

- Click on the **OK** box. The **Fish--Wt. vs. Life Span** graph should appear.

Make a general statement about the relationship between the weight of fish and their life span.

- Which of the **three** hypotheses in **Part I** of step **7** is correct?

10. To view the second graph:

- Pull down the **Window** options and select the **Fish--Heart Rate (SS).**

- Expand the **Fish--Heart Rate (SS)** to the full window by clicking on the zoom box.

- Pull down the **Chart** options and select **Draw Chart....**
  The Fish-Wt vs. Heart will be **selected** (highlighted).

- Click on the **OK** box. **The Fish--Wt vs. Heart** graph should appear.

Make a general statement about the relationship between the weight of fish and their heart rates.

- Which of the **three** hypotheses in **Part II** of step number **7** is correct?

11. Jot down some thoughts on why you would choose to use the computer as demonstrated in this activity in some class that you teach.

12. Closing the files.

- Pull down the **File** options and select **Quit**.

If the computer asks if you want to save any changes:

- Click the **NO** box.

The mini-finder screen (to the left) should display the following pictures (**Icons**): **Microsoft Wo..., Mammal File..., Fish Files, Explore Spr..., Kinematics, Explore Data, and Energy Balance**.

Skills for Success in Science

List some of the skills needed by your students to achieve success in science.

1.

2.

3.

4.

5.

6.

Summarize the ideas listed above into one or two key ideas.

Organizing and Graphing Data To Answer Questions:
Part II

After working with the data on fish you might want to know if mammals display similar relationships (or lack of relationships) when weight is compared to heart rate and life span. Before looking at the data, select the hypotheses that you think best describes:

I. The relationship between the life span and the weight of a mammal.

- The life span of a mammal *lengthens* as the weight of the mammal *increases*.
- The life span of a mammal *lengthens* as the weight of the mammal *decrease*.
- The weight of mammals has *no effect* on the life span of mammals.

II. The relationship between the heart rate and the weight of mammals.

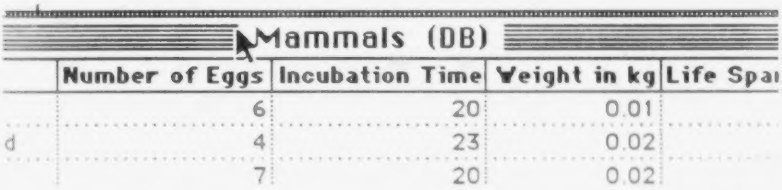
- The heart rate of a mammal *increases* as the weight of the mammal *increases*.
- The heart rate of a mammal *decreases* as the weight of the mammal *increases*.
- The weight of mammals has *no effect* on the heart rate of mammals.

Use this space to write comments about your analysis of the ideas in the above questions.

1. Selecting and opening a desktop.
    - Highlight the desktop **Mammal File**.
    - Click on the **OPEN** box.

   Three small windows will appear: **Mammals** (DB), **Mammals--Wt vs. Heart Rate** (SS), and **Mammals--Wt vs. Life Span** (SS).

2. Selecting and opening a file.
    - Double-click on the **title bar** of the **Mammal** (DB).



	Number of Eggs	Incubation Time	Weight in kg	Life Spa
	6	20	0.01	
d	4	23	0.02	
	7	20	0.02	

It should open to a **full** window.

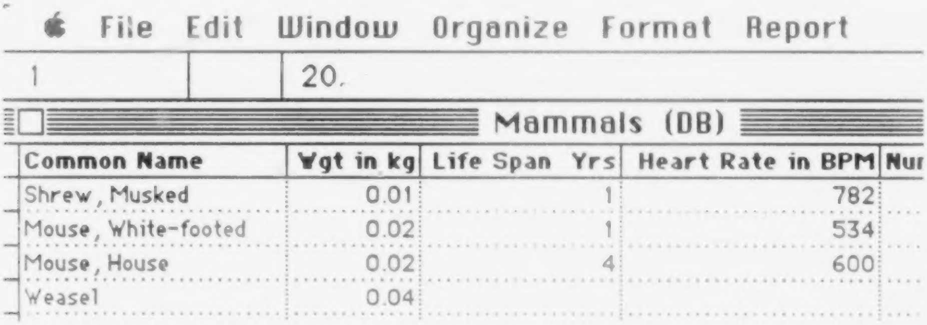
3. Viewing the data.

   - Use the **horizontal scroll bar** to examine the different **fields** in the database.
   - Use the **vertical scroll bar** to examine all the **records** in the database.

4. Moving fields in the database.

   Relationships between fields are easier to see when the fields are next to or close to each other.

   - Move the **Wgt in kg**, **Life Span Yrs**, and **Heart Rate in BPM** fields so they are in the order shown below.



Common Name	Wgt in kg	Life Span Yrs	Heart Rate in BPM	Nur
Shrew, Musked	0.01	1	782	
Mouse, White-footed	0.02	1	534	
Mouse, House	0.02	4	600	
Weasel	0.04			

   - Point the cursor at the **field title** (a small hand will appear) of the field you wish to move.
   - While **holding the mouse button down** move the hand (cursor) to where you want the field located.
   - Release the mouse button.

Looking at the data in chart form may not be enough to convince you that the relationship selected in **Part I** is correct. Sometimes relationships are easier to see if the data is represented as a picture. Let's examine computer generated graphs to help us determine which hypotheses are correct.

5. Accessing computer-generated graphs

   Select and open the file **Mammals--Wt vs. Life Span (SS)** by doing the following:

   - Point the cursor (arrow) to the word **Window** in the **Menu** bar.

- Pull down the **Window** options by holding down the mouse button.
- Move the cursor down until **Mammals--Wt vs. Life Span** (SS) is highlighted (selected) then release the mouse button.

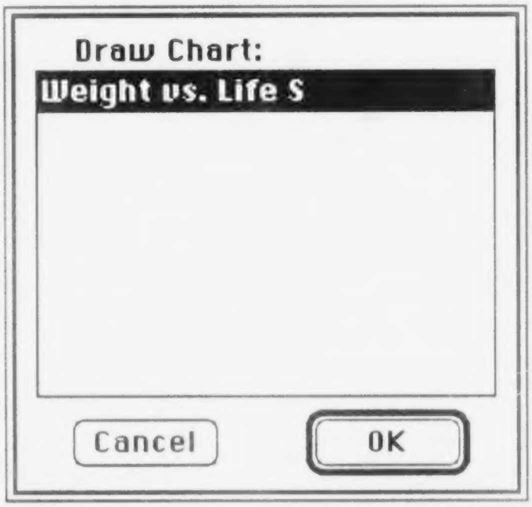
The small window displaying the **Mammals--Wt vs. Life Span** (SS) should appear.

- Place the cursor within the **title bar** of **Mammals--Wt vs. Life Span** (SS) .
- **Double-click** (press the mouse button twice). This should open the file to a **full** window.

To examine the graph of weight vs. life span:

- Point the **cursor** to the **Chart** options and pull down the menu.
- Select the **Draw Chart...**option.

The following message box will appear.



- Click on the **OK** box.

The graph **Weight vs. Life S** should appear.

After looking at the graph, can you make a general statement about the relationship between the weight of mammals and their life span?

- Which of the three hypotheses in Part I is correct? _____

Examine the graph of weight vs. heart rate:

- Pull down the **Window** options and select the **Mammals--Wt vs. Heart Rt (SS).**
- Expand to a **full** window (**Double-click on title bar**).

- Pull down the **Chart** options and select **Draw Chart**.
- A message box will appear. Click on **OK**.

The graph **Mammal Weight vs. Heart Rate** should appear.

Examine the graph. Can you make a general statement about the relationship between the weights of mammals and their heart rates?

- Which of the three hypotheses in Part II is correct? _____

7. Closing the files.

- Pull down the **File** options and select **Quit**.

If the the computer asks if you want to save any changes

- Click the **NO** box.

The mini-finder screen (to the left) should display the following pictures (**Icons**): **Microsoft Wo..., Mammal File..., Fish Files, Explore Spr..., Kinematics, Explore Data, and Energy Balance**.

Session Descriptions

Session 1: Hypothesis Testing Using a Computer

The session will illustrate how organizing data and electronic graphing of data can help students generate hypotheses and confirm or deny hypotheses. The main focus of the inservice sessions is on the use of computers in hypothesis testing and problem solving in science. The first session provides a basic introduction to use of a powerful microcomputer with a relatively sophisticated piece of software, Microsoft *Works*.

Session 2: Searching and Sorting Databases to Generate and Test Hypotheses

Using Microsoft Works we will modify a database to answer questions. The issue of when and how to use a database in the science classroom will be addressed. As in all hands-on sessions, there is more emphasis on when and why to use a computer than on specific details of the key presses needed to use a particular piece of software. Participants are expected to gain skill in actually using the computer through their computer use outside of the inservice sessions.

Session 3: Creating a Database for Testing Hypotheses

This session will illustrate how to create a database file using Microsoft *Works*. The ability to create a database opens a wide range of possibilities for integrating the computer into the science curriculum. Information on creating a database using *AppleWorks* will also be provided.

Session 4: Introduction to a Spreadsheet

Using Microsoft *Works* we will become familiar with the components and structure of a spreadsheet. Activities will demonstrate how to graph data from a spreadsheet.

Session 5: Creating a Spreadsheet

This session will illustrate how to create a spreadsheet using Microsoft *Works*. We will explore the use of a spreadsheet as a teacher and student tool. The advantages and disadvantages of using a spreadsheet as a "black box" utility will be discussed.

Session 6: Using an Integrated Package to Produce a Lab Report

This session will demonstrate how an integrated software package combines the applications discussed in the previous sessions: database, spreadsheet, and electronic graphing. A laboratory report will be constructed using information from data bases and spreadsheets.

Session 7: Investigation of Some Commercially Available Science Education Software

This session is divided into two parts: 1) the demonstration and evaluation of some commercially available databases and/or other science education software; and 2) a demonstration of using the computer as a data collection device (use of probeware). Note: The latter topic may be dropped in order to spend more time on the former topic.

Session 8: Projects and Closure

School administrators from the participant's schools will be attending. Other higher level school district administrators and the district computer coordinator will also be invited. During the last session, teams of participants will present their final projects. Each project presentation will be a maximum of *10 minutes*. It is important that these presentations be carefully prepared and accompanied by appropriate handouts. Following each project presentation, the project team will initiate a brief discussion (approximately five to ten minutes) between administrators and project participants. The theme of the discussion is what administrators can do to help teachers integrate computers into the science curriculum.

Science Skills

Communication of Results

Data Collection

Data Organization

- diagram
- chart form
- picture

Generating and testing Hypotheses

Interpretation of Data

- charts/diagrams
- graphs
- calculations

Observation

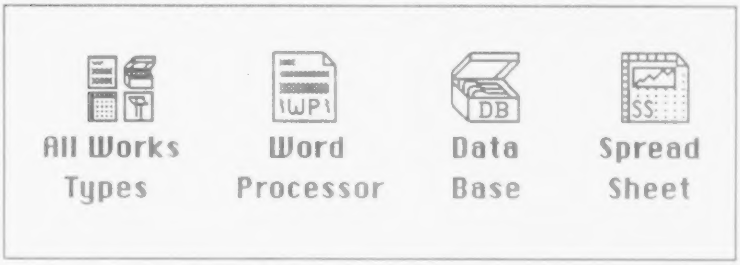
Glossary

Hardware Terms

External Drive:	The 3.5 inch disk drive located next to the computer. (A Macintosh SE may have two internal 3.5 inch disk drives. The top one of these is considered to be the external drive.)
Hard Disk Drive:	Many microcomputers contain an internal or external hard disk drive. If it is internal, it automatically starts up when the machine is turned on. If it is external, first turn it on and wait for about 10 seconds for it to reach full speed. Then turn on the computer.
Internal Drive:	The 3.5 inch disk drive located within the Macintosh Plus or SE computer below the screen.
Mouse:	The device that allows you to move the cursor and control options selected on the screen.

Desktop Terms

Cursor:	The pointer which appears on the screen. At the desktop level the cursor will appear as an arrow.
File:	A collection of information that has been stored on the disk.
Icon:	The "picture" that represents an object, concept, message, or collection of information.



Window Terms

Close Box:	The small white box at the far left side of the title bar. Clicking on a close box closes the window and removes it from the desktop.

Cursor:	The pointer that appears on the screen. A window cursor can appear in three forms: 1) a blinking line 2) an I-beam 3) a hand
Scroll Bar:	A rectangular bar that appears along the right or the bottom of a window. Clicking in the scroll bar moves up, down, left, or right in the window.
Scroll Box:	The white box in the scroll bar. The position of this box within the scroll bar indicates the position of the information in the window relative to the entire file.
Title Bar:	The horizontal bar at the top of a window that indicates the title and contents of a window.
Zoom Box:	The small white box at the far right end of the title bar. Clicking on the zoom box enlarges a "sized" window to full screen size.

"How To" Terms

Click:	Position the cursor and then quickly press and release the mouse button.
Close:	Put the document away, or remove it from the desktop.
Double Click:	Two "clicks" in rapid succession.
Drag:	Position the cursor, press and hold the mouse button down. Move or drag the mouse to a new location, then release the mouse button. This action moves an object to a new location or confirms a command selection.
Highlight:	To highlight, click on the object. This makes the area visually distinct from the background and shows that the information has been selected.
Open:	Make the contents of a file available for processing.
Save:	Store information on a disk.
Select:	Choose a command, window, or area that is to be acted on.

QUICKSTART READY REFERENCE GUIDE TO *FrEdWriter* - STARTING

Note: This material is from FrEdWriter Documentation DOC.A.

BASICS

FrEdWriter is a very easy word processor to learn. You must know 4 things when you are writing with *FrEdWriter*:

1. Most of the keys on the keyboard will make letters on the screen.
2. Press the **DELETE** key to erase mistakes.
3. Press the **ARROW** keys to move the cursor around the text.
4. Press **Control-T** to see the <T>utor which tells you more about *FrEdWriter* commands.

TYPING *FrEd* COMMANDS:

FrEdWriter commands look like this: <P>rint.
They are typed this way:

1. **PRESS** the **CONTROL** (or CTRL) **KEY** at the left side of your keyboard.
2. **KEEP** it down while you **STRIKE** the letter inside the < >.

LOADING DOCUMENTATION

The *FrEdWriter* disk contains complete documentation, written by June Wedesweiler Dodge of San Diego CUE. It is contained in four text files called: DOC.A, DOC.B, DOC.C and DOC.D. You can use *FrEdWriter* to load, read, and print them.

Here's how you **load** DOC.A when you are in *FrEdWriter*:

1. Type the <**N**>ew command (**Control-N**). At the prompt located at the bottom of the screen, type '**Y**' and press **RETURN**.
2. If you are using a 40-column screen (large type), type the <**W**>idth command (**Control-W**). At the prompt located at the bottom of the screen, type '65' and press **RETURN**. (The right side of the text will be invisible at first. Use the Right-Arrow to see it all.)
3. Type the <**L**>oad command (**Control-L**). At the prompt at the bottom of the screen, type 'DOC.A' and press RETURN.

PRINTING DOCUMENTATION

1. Load DOC.A as described in LOADING DOCUMENTATION above.
2. Type the <P>rint command (**Control-P**), press **RETURN**.
3. Tap the **ARROW** key until you highlight TOP LINE, press **RETURN**. Type '***** FrEdWriter Documentation DOC.A Page # *****' and press **RETURN**.
4. Check to be sure the printer is on; then press **RETURN**.
5. When printing is done, repeat for DOC.B, DOC.C, DOC.D.

QUICKSTART READY REFERENCE GUIDE TO *FrEdWriter* - COMMANDS

Here is a complete list of *FrEdWriter* Commands. This same list is also in the <T>utor inside *FrEdWriter*. Details about each command are found in the reference to the right.

Apple II, II Plus, //e and //c	**REFERENCE IN DOCUMENTATION**
<T> = SHOW THIS TUTOR	DOC.C-2
<P> = PRINT this document	DOC.D
<S> = SAVE from memory to disk	DOC.B-3
<L> = LOAD from disk to memory	DOC.B-2
<F> = FIND and replace words	DOC.C-8
<W> = Change page WIDTH	DOC.D-3
<C> = Use with arrows to CHANGE CASE	DOC.C-12
<R> = REVEAL/Hide Paragraph Markers	DOC.C-4
<B> = Jump to text BEGINNING	DOC.C-3
<E> = Jump to text END	DOC.C-3
<N> = New Page (erase memory)	DOC.B-2
<Q> = QUIT FrEdWriter (Return to Menu)	DOC.C-12
<V> = Accept Control Keys as Letters	DOC.D-05
ESC = Change the page top line	

Additional quick-reference comments:

Apple //e and //c	**Apple II and II Plus**
Left/Right-arrows	Left/Right-arrows
Up-arrow (line)	Control-A
Open-Apple-Up-arrow (paragraph)	Shift-Control-A
Down-arrow (line)	Control-Z
Open-Apple-Down-arrow (paragraph)	Shift-Control-Z
DELETE key (erase letter)	Control-D
Open-Apple-Delete (erase line)	Shift-Control-D
TAB key (5 spaces)	Control-I
CAPS LOCK key	Shift-ESC
Open-Apple Left/Right-arrows (block move)	Shift-Control-arrows
Open-Apple-P (Prompt Box Mode)	Shift-Control-P
Open-Apple-A (top line)	Shift-Control-S
Open-Apple-Z (bottom line)	Shift-Control-X
Open-Apple-R (removes prompts)	Shift-Control-R
Open-Apple (pauses scroll through prompt box)	Shift

Name ______________________________

Participant Objectives
(A Formative Evaluation Instrument)

We are interested in learning why you are attending this program. Please state briefly and specifically what you would like to gain from this training. At the last session, you will be asked to indicate how well each of your objectives was met.

Objective	Unmet			Met
1. ______________________________	1	2	3	4
2. ______________________________	1	2	3	4
3. ______________________________	1	2	3	4
4. ______________________________	1	2	3	4

(This form is based on Phil Browning's *The Impact of Nationwide Training Programs to Promote Self-Advocacy*, and revised with permission of the author.)

Note: Participants should be provided with one copy of this Log Sheet for each week of the inservice series. You may want to hand out all of these copies during the first session, or hand out one copy each week. In any event, you will probably want to write specific dates on each sheet and/or beside each of the days listed. A sample is given below.

Name: ______________________________

CI^3 Participant Log

Please use this form to record all your computer related activities, both at school and at home.

Wednesday, Sept. 30

Thursday, Oct. 1

Friday, Oct. 2

Weekend, Oct. 3-4

Monday, Oct. 5

Tuesday, Oct. 6

General comments and/or questions you would like some feedback on from the inservice facilitator:

Game of the Week

One copy of the Fish Database is given on the next page. Take some time and examine the database. Develop two or three questions not addressed during Session 1 that could be answered by reordering the fields in the database and ordering the data in ascending or descending order.

It might be easier to develop questions if you physically change the order of the fields. Feel free to make additional photocopies of the database and to cut up the database so you can move the fields and order them according to your interests.

Please write the questions you come up with on this sheet. If you like, paste your database back together and attach it. I am extremely interested in how you arrange the database fields.

You may want to try this exercise with some of your students. Feel free to make copies of the fish database for such purposes. If you try out this activity with your students, please write up the results as part of your Game of the Week report.

Common Name	Weight in Kg	Heart Rate in BPM	Life Span in Years	Number of Eggs or Litter Size	Incubation Time in Days	Blood Press. in mm Hg	Number of Chromosomes
Pumkinseed	0.31		3	4000	7		
Bullhead, Brown	1.13	22	9	6000	5	22	
Sea Lamprey	1.14		7	236000	28		
Mackerel, Spanish	1.59		5	20000	5		
Perch	1.95	59	10	30000	14		28
Flounder, Winter	2.27		1	1000000	15		
Haddock	3.30	35	15	1000000			
Bass, Large Mouth Black	10.10		11			50	
Gar, Longnose	18.00		30	36500			
Trout, Brown	18.16	38	18	15000	31		
Trout, Rainbow	18.16		4	1700	22	40	62
Pike, Northern	19.06	42	24	100000	15	60	18
Cod, Atlantic	22.70	48	13	6000000	17	29	
Sting Ray	27.24			4		16	
Carp	38.00	59	6	2000000	9	43	104
Tuna	45.36		7	2000000	2		102
Sturgeon, Atlantic	226.96		50	1800000	5		
Shark, Hammerhead	272.35	25	18	33		33	

4.1.5 Student Materials

This Materials sections of the Notebook contains sample lesson plans and other materials designed for inservice participants to use with their students. This particular Materials section contains a number of activities that can be done with one particular database, the MECC North *American Mammals*. This is an Apple IIe database. However, even if you do not have access to this software and hardware, you will find that it is easy to transfer the general nature of these activities to other databases that you do have available for use with your students.

The designers of these CI^3 materials made the decision to base the inservice sessions mainly on Macintosh computers and the Microsoft *Works* package of software applications. However, many of the participants had other types of computers in their schools. Thus, they were not able to take some of the inservice ideas and easily apply them with their students. Handout materials such as in this section helped a little to circumvent this problem. (Quite a few of the participants already knew how to use Apple IIe microcomputers, and that is what they had available in their schools.)

The particular materials given in this section are designed for a classroom setting in which small groups of students can work together at a computer. The materials can, with slight modification, be used in a whole class setting. This requires a large screen monitor or projection system.

Index to Materials	Page
Using a Database to Study Herbivores	2

Using a Database to Study Herbivores

These activities were designed for use with MECC *North American Mammals* software in a computer laboratory situation. Students can work individually, in pairs, or perhaps in groups of three. It is assumed that students have previously learned how to make use of computers and such software, and that appropriate computer facilities are available.

Testing Hypotheses Using a Database

Habitat is where an animal lives. Before you get started using the computer, think about what the word habitat means to you. Then think about the word herbivore. The database you will be using contains information about a number of different herbivores. Perhaps you already know a great deal about herbivores.

Select the hypothesis that you think best defines the term "herbivore."

- A herbivore eats other animals.
- A herbivore eats fish.
- A herbivore eats plants.
- A herbivore eats both plants and animals.

The database contains information describing the habitats of 23 herbivores. Examining this information may help us confirm or deny our hypotheses. We assume that you have booted the software and are on the screen that allows you to select records from the database.

- Look at your computer screen. **Select Records** should be highlighted. Press **Return.**

To select the records of the 23 herbivores:

- Press the down arrow key until the category "Eating habits " is selected. Press **Return.** A new screen will appear listing different types of eating habits.
- Press the down arrow key until the category "herbivore " is selected. Press the spacebar. An arrow will appear to the left of the category herbivore. If the arrow does not appear raise your hand.

- After the arrow appears to the left of the category herbivore press **Return.**

Pressing Return caused the computer to select out the 23 records that describe various features of herbivores.

- Look at the upper left corner of the screen. It should read:

Selection: 23 of 98 records

If it does not, please raise your hand to get help from the teacher.

To print the information to the screen, press the ESC key in the upper left corner of the keyboard. The computer screen should look as follows:

Dataquest: N.A. Mammals

Selection: 23 of 98 records

1. Select Records
2. Sort Records
3. Print Current Selection
4. Information
5. Other Activities
6. Quit

- If you are having problems, please raise your hand.

To display the information on habitats:

- Press the down arrow key until **Print Current Selection** is highlighted. Press **Return.**

To print the information as a table:

- Press the down arrow key until **Table (across page)** is highlighted. Press **Return.**

To print only the categories **Eating habits** and **Habitat:**

- Press the down arrow key until **Habitat** is highlighted. Press the spacebar; an arrow will appear to the left of the category habitat.
- Use the down arrow key to highlight **Eating habits**. Press the spacebar; an arrow should appear to the left of this category. After the arrow has appeared press Return.

The current computer screen describes how the information will appear when printed. To continue:

- Press **Return**

To print the information to the computer screen

- Press **Return**
- Use the arrow keys to examine the habitats of the different herbivores.
- In the space provided, write the names of the habitats in which the different herbivores lives.

HABITAT

Grouping the habitats that have similar features may help identify a pattern supporting or eliminating one of the previous hypotheses. Working with a partner, try grouping the habitats that have something in common. This is a small data set, so limit yourself to 3 different groups. Take 5 to 10 minutes for identifying groups and write your results in the space provided below.

Habitats	Features in Common

Habitats	Features in Common

Habitats	Features in Common

- Did grouping the habitats help confirm or deny the hypothesis? In 2 or 3 sentences describe what you learned from grouping the habitats?

More information may be necessary to help confirm, deny, or modify the hypothesis. For example, what an animals eats (diet/prey) may provide additional clues about what is a herbivore.

To print the information related to diet/prey:

- Press ESC. The following will appear on the screen

Print to:

1. Screen
2. Printer
3. Report File

- Press ESC.
- The computer screen should display how the information will look when printed out. If it does, press ESC; if not, get help from a teacher.
- The computer screen should display the categories of information that can be printed. Use the down arrow key to highlight **Diet/Prey**. Press the spacebar. An arrow will appear to the left of the **Diet/Prey** category, press **Return 3** times to display this information on the computer screen.
- Use the arrow keys to examine the diet of the 23 herbivores.
  In the space below, write the names of the different foods eaten by a herbivore.

- Does this information support the hypothesis selected by your group? Why or why not?

- In 2 or 3 sentences write a hypothesis that defines the term herbivore.

Generating Hypotheses

There may be a relationship between what an animal eats and its limb structure (claws, flippers, hands and feet, hoofs, webbing, or wings). In 2 or 3 sentences generate a hypothesis that describes the limb structure of a herbivore.

Select two or three database categories that might provide information to help confirm, deny, or modify your hypothesis. Use the following data collection sheets to record your observations.

DATA COLLECTION SHEET

Database Category: ____________________

Description of findings:

DATA COLLECTION SHEET

Database Category: ____________________

Description of findings:

____

____

____

____

____

DATA COLLECTION SHEET

Database Category: ____________________

Description of findings:

____

____

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____

Testing Hypotheses Using a Database

In this section we will generate and test some hypotheses about herbivore offspring. Before beginning to use the computer database to examine this topic, do the following, based on your personal knowledge:

Select the hypothesis that describes the number of herbivore offspring.

- Herbivores have only 1 offspring.
- Herbivores have 1-2 offspring.
- Herbivores have 3-4 offspring.
- Herbivores have more than 4 offspring.

Sorting the information related to the number of herbivore offspring is one way to test the hypothesis you selected. The computer can sort the data from lowest to highest, or highest to lowest. To sort a category:

- Press the ESC key until the following appears on the computer screen.

Dataquest: N.A. Mammals

Selection: 23 of 98 records

---

1. Select Records
2. Sort Records
3. Print Current Selection
4. Information
5. Other Activities
6. Quit

To sort data:

- Press the up or down arrow key to highlight **Sort Records**.
  Press Return.
- Press the down arrow key until **Number of offspring** is highlighted. Press Return.
- Highlight one of the sort options **From Lowest to Highest** or
  From Highest to Lowest. Press Return.

When the computer has finished sorting the information it will Return to the previous screen (Sort records based on which category).

- Press ESC.

To print the sorted information

- Highlight **Print Current Selection**. Press Return.
- Highlight **Table (across page).** Press Return.
- Highlight **Name** and press spacebar.
- Highlight **Number of offspring** and press spacebar.

Any category with an arrow to the left will be printed. If there are any categories that you do not wish to print:

- Highlight the category and press the spacebar. The arrow will be removed.
- Press Return three times to print the information to the screen.

Examine the sorted data for patterns or trends.

Number of Offspring	Name of Animal

Did sorting the data on the number of offspring support the hypothesis you selected? Write two or three sentences explaining why or why not.

- Select two or three database field categories that might provide information about what influences the number of herbivore offspring. For each category circle yes if the data is to be sorted before printing to the computer screen. Use the following data collection sheets to record your observations.

Database Category	Sorted
____________	yes no
____________	yes no
____________	yes no
____________	yes no

DATA COLLECTION SHEET

Database Category: ____________

Sorted: YES NO

Description of findings:

____

____

____

____

____

DATA COLLECTION SHEET

Database Category: ____________

Sorted: YES NO

Description of findings:

____

____

____

____

____

DATA COLLECTION SHEET

Database Category: ____________________

Sorted: YES NO

Description of findings:

____

____

____

____

____

In two or three sentences write a hypothesis that describes what influences the number of herbivore offspring. (Be aware that the hypothesis you are now writing is based on examination of a rather limited set of data. The next step in a careful investigation of this area might be to obtain data from a larger collection of herbivores in order to further test and perhaps refine your hypothesis.)

4.2

Session 2: Searching and Sorting Databases to Generate and Test Hypotheses

4.2.1 Narrative Overview

The goal of Session 2 is to demonstrate how databases can be used to facilitate generating and testing hypothesis in the science classroom. The session demonstrates how teachers and students can use a database to practice the following skills: (a) organizing data in a systematic manner, (b) using organized data to answer questions, (c) visually inspecting data looking for relationships or general trends, (d) translating relationships or trends into hypotheses, and (e) reorganizing information to help confirm or deny a hypothesis. The materials assume no previous experience with databases and are not intended to develop teacher mastery in the design and implementation of a database or in database operations (searching and sorting). Specific modifications for development of participant mastery with databases are suggested at the end of the overview.

Activity 1 (Introduction to Database Operations) introduces the concept of a database and demonstrates how to use a database to generate hypotheses and to develop strategies to test the hypotheses. In the process, Activity 1 introduces participants to different ways of organizing information in a database (list, record) and introduces the sorting (alphabetic and numeric) and selecting of records. The primary goal is to develop positive teacher attitudes toward this instructional use of databases. The CI^3 Project hypothesizes that teachers will be willing to devote the time and energy necessary to learn database skills and develop classroom materials if they believe it will be beneficial to their students.

Activity 1 is highly structured. It directs participants (later on students) to visually inspect two fields that reveal an obvious pattern. This allows the lesson to include a predefined testing strategy. Before using the database to test the relationship, participants translate it into a question or hypothesis. While teachers may not require such detailed directions, this is an unfamiliar learning environment for most students. Activity 1 demonstrates how a lesson can help students overcome initial fears they may have about working in an unfamiliar situation. Remember, students are not used to this type of instructional strategy.

The debriefing following Activity 1 should concentrate on describing the design of the activity and its rationale, and making explicit how the activity introduces students to a database within the context of a science lesson.

Activity 2 (Using a Database to Generate Hypotheses) uses a less structured approach to extend the ideas introduced in Activity 1. Activity 2 demonstrates how students can use a database to practice generating and testing hypotheses within the context of traditional science content. The activity is divided into three parts and each part could be expanded into a separate activity.

Part 1 of Activity 2 introduces how the selecting capability of the database can be used as a simple testing strategy to help confirm or deny a hypothesis. Participants are instructed to develop a definition for the term "ambient" after examining a small set of vertebrate records. The activity provides the selection criteria and detailed instructions on how to select records.

Part 2 of Activity 2 demonstrates how to develop a more complex testing strategy by combining database operations. The design is structured to select certain records from the database and then sort them. The lesson is highly structured and provides participants with the following information: (a) the fields that reveal an obvious relationship (number of eggs or litter size of different vertebrates, and the number of months each cares for its young), (b) the search strategy, and (c) instructions on how to execute the search.

Part 3 of Activity 2 also demonstrates a complex testing strategy, but reverses the design used in Part 2. In Part 3 participants test by numerically sorting the records and then selecting out those that relate to mammals. Its design is similar to Part 2 in providing participants with: (a) the fields to compare (incubation time in days and weight in kg), (b) the search strategy, and (c) instruction on how to execute the search.

Focus the debriefing on the lesson components, not the operation of the computer or the software. Keep in mind the primary objective of Activity 1 is to demonstrate how a database can be used as a instructional tool in the science curriculum. Remind participants that the activity is not designed to develop mastery in using databases.

Activity 3 (Generating Hypotheses with a Paper Database) demonstrates an open ended off-computer activity. In this activity participants are not provided with suggestions as to what fields to examine for potential relationships. They are instructed to generate three hypotheses and develop search strategies to help them confirm or deny the hypotheses. Time should be provided for participants to test their search strategies and if possible modify them. Activity 3 also demonstrates how teachers can provide students practice in generating and testing hypotheses when computers are limited. This type of activity can be used by half the class while the others are engaged at the computers. The debriefing of Activity 3 should make explicit that this is not recommended as a way to introduce students to the concept of a database or database operations. For this activity to be effective, participants (and later on students) need to feel comfortable exploring and developing hypotheses or testing strategies that may result in dead ends.

The Game of the Week is designed to help participants identify databases that are already part of their curriculum. The goal is to help participants locate sources of information that they would like to convert into an electronic database.

If your inservice goal is for participants to develop a functional knowledge of how to use a database to generate and test hypotheses, you will find it necessary to have more than one two-hour session on this topic. It is recommended that Session 2 be expanded from one to three sessions. Specific modifications include (a) expanding Activity 2 into three separate activities to provide teachers with additional practice in developing mastery with a database, and (b) devoting one two-hour session to the development of lessons that model the principles demonstrated in Session 2.

To facilitate lesson development, provide participants with several examples of paper databases. The examples should reflect the current teaching assignments of participants. Have teachers develop a lesson, complete with lesson plan and activity sheets. Provide teachers time to pilot and revise their lesson plans. It is unlikely sufficient time is available for all participants to engage in peer teaching, but solicit some volunteers for this purpose. Videotaping the volunteers is highly recommended. If videotaping has been done, include time to review the tapes as a group activity.

As you consider the organization of the second inservice session, think about the wide variety of participants in your inservice. Likely they range in computer background from complete novices to "close to" experts. Also, their science and teaching background and experiences likely vary over a wide range. It is a challenge to work with such a varied group. It is important that you get participants involved in helping you as much as possible. For each new topic, seek out knowledgeable participants who can help the novices get started. If some of the participants have a great deal of experience in a particular type of computer use related to a class topic, have them share this experience. Perhaps the best way to think about it is that each participant in your inservice is an educator and brings a great deal of knowledge and experience to the inservice. One of your tasks is to take appropriate advantage of this pool of talent, knowledge, and experience.

It is important to be aware that for many of the participants you are trying to do two things simultaneously. You are trying to help them learn about computers and you are trying to help them learn that science teachers should teach hypothesis generation and hypothesis testing. In many cases the latter may be the more important of the two goals!

4.2.2 Script

Theme

Using a database to generate and test hypotheses.

Objectives

1. Demonstrate how a database can be used to facilitate generating and testing of hypotheses
2. Demonstrate how a database can be used to practice the following skills:
   - organizing data in a systematic manner
   - using organized data to generate hypotheses
   - visually inspecting data looking for trends or general relationships
   - reorganizing data to help confirm or deny hypotheses

Materials

Software	***Hardware***
Microsoft *Works*	Macintosh computers with
Data disk	appropriate secondary memory

Handouts

Activity 1 (Using a Computer to Generate and Test Hypotheses)
Activity 2 (Using a Database to Generate Hypotheses)
Activity 3 (Generating Hypotheses with a Paper Database)
Game of the Week
Participant Log
What's a Database
Modifying a Database

Resources

overhead projector
overhead marker
blank transparency
refreshments

Setup

Before participants arrive have copies of Microsoft *Works* and the data disk at each computer. The computers will be turned off.

Introduction

The materials for this session assume no previous experience with databases. The materials are not intended to develop participant mastery in the design or implementation of a database or in specific database operations (searching and sorting). The primary goal is to develop positive teacher attitudes about using databases for the generation and testing of hypotheses.

Activity 1
20 minutes

Purpose: Using a Computer to Generate and Test Hypotheses is designed to familiarize participants with: 1) the concept of a database, 2) how information can be organized in a database (list and record), 3) how to move around in a database, sorting records alphabetically and numerically, 4) translating relationships or trends into hypotheses, and 5) testing hypotheses by reorganizing and graphing data. Participants will develop awareness of the ways in which computers can facilitate access to large bodies of information.

Participants will boot the system according to directions on the performance aid. The performance aid directs participants in how to scroll through a database, view data as a list or record, and sort records (alphabetically and numerically). The trainer will circulate and provide assistance when necessary.

Debrief
15 minutes

Elicit responses from participants concerning their feelings about the activity. Make explicit that in a database information can be organized as a record or list. Define the term field. Have participants name some of the fields in the database used in Activity 1. Have teachers discuss the amount of class time they currently provide for students to generate and test hypotheses. Have participants suggest areas in their curriculums where databases could be used by students to practice generating and testing of hypotheses.

Activity 2
20 minutes

Purpose: Using a Database to Generate Hypotheses demonstrates how students can practice generating and testing hypotheses using a database with traditional science content. It is a less structured approach that extends the ideas introduced in Activity 1. The activity demonstrates how to generated a hypothesis by: 1) examining a specific field for a large number of records, 2) combining the selecting and sorting capabilities of the database into a testing strategy, and 3) sorting records and then selecting according to certain criteria.

Break
10 minutes

Break: Relax, mingle, refresh.

Debrief
20 minutes

Elicit from participants what happened and what they discovered by completing the activity. Focus the discussion on the how using databases allows students to work with larger data sets. Discuss the advantages of large data sets for: 1) generating hypotheses, 2) identifying trends or patterns, and 3) testing hypotheses. Have teachers identify why in the past this type of activity was difficult to incorporate into the science classroom. Conclude this segment of the debriefing by talking about the advantages of using a database for generating and testing hypotheses.

End the debriefing by discussing how you determine the type and quantity of information to include in a database. This will prepare participants for the concepts to be introduced during Session 3.

Activity 3
15 minutes

Purpose: Generating Hypotheses with a Paper Database demonstrates an open ended, off computer activity.

Debrief
15 minutes

Start the debriefing by asking teachers to develop an instructional plan to incorporate all three activities. Point out that off computer activities are one way to deal with limited hardware and software resources. They also provide students with additional process skills practice that can be assigned as an out of class activity.

Closure
5 minutes

Game of the

Briefly discuss results from last week's Game of the Week. Work on getting

Week	participants to share their experiences. Indicate also that their writings provide valuable feedback to you.
Think Ahead	Remind participants of the location of next week's session, and that the lab will remain open for one hour after this session ends. Who is providing refreshments for next time? Find out if any participants have found additional access to computers on their own, and if this access might be sharable among the inservice participants.

Evaluation Indicators

Did the participants seem to enjoy themselves?
Did they become more comfortable with the operation of the program as the session continued?
Were they able to generate some extensions and possible applications of database activities and capabilities for their own classrooms?
Did they seem excited by their new skills and discoveries?
Were the novice computer users comfortable?
Were the experienced users challenged or allowed to explore in other directions (computed fields, etc.)?
Did the participants demonstrate a fairly solid understanding of a database during the final debriefing discussion?
Did they leave with a feeling of open endedness in terms of possible applications of databases and generating and testing hypothesis in their own science classroom?

4.2.3 Timeline

Before participants arrive, place copies of Microsoft *Works* and this session's Data disk at each computer. Machines will be turned off.

0:00 - 0:20
20 min

Participants will complete Activity 1. Encourage them to work in pairs. The object of the activity is for participants to become familiar with:

- the concept of a database
- organizing information as a list or an individual record
- scanning a database looking for relationships, trends, or patterns
- sorting records (alphabetically and numerically) in the database
- translating relationships, trends, or patterns into hypotheses
- testing hypotheses by reorganizing and graphing of data

0:20 - 0:35
15 min

Collect:

- Game of the Week
- Weekly Logs

Debrief Activity 1: Discuss the characteristics of a database:

- records
- fields
- form organization
- list organization

Questions for participants to consider:

- What are differences between the record and the list formats ?
- Identify and list advantages of each.
- Identify and list situations/activities appropriate for each.
- What factors are important to consider when analyzing data in chart versus graph form?
- When is more effective to have students access prepared graphs, and when is it more effective to have students plot the graphs by hand?

Have participants discuss:

- amount of class time allocated to students generating and testing of hypotheses
- appropriateness of this instructional strategy
- why it is difficult to do and how a database might help make it easier

Make explicit the format of each session:

- Activity 1 — participant in mode of adult learner
- Activity 2 — modeling how to integrate concept into the classroom, teacher role-playing student

0:35 - 0:55
20 min

Activity 2: Instruct participants to complete the activity in the role of a student. They will practice using a database to:

- generate hypotheses
- develop testing strategies using the sorting and selecting capabilities of a database

0:55 - 1:05
10 min

Break

1:05 - 1:25
20 min

Debrief the Game of the Week. Collect reconstructed databases and teacher questions. Ask teachers to share materials. Discuss the results participants obtained when doing this activity with students. Make explicit how this activity introduces students to the concept and capabilities of a database within the context of a science lesson (an integrated approach).

Debrief Activity 2. What happened? What did participants discover by completing the activity?

- What factors influence the number of fields and the amount of data necessary to use a database effectively in a classroom?
- How do you determine what information to include in a database?
- What advantages are there to hypothesis testing with a database?

Have participants identify the design components of the lesson:
- highly structured
- model for introducing students to instructional strategy
- identify and list student apprehensions associated with this type of instructional strategy

1:25 - 1:40
15 min

Activity 3. Off computer. Have participants work in groups. Each group will:
- generate three hypotheses
- develop testing strategies for each hypotheses

1:40 - 1:55
15 min

Debrief Activity. As a group develop a curriculum sequence to integrate this lesson into the curriculum.

1:55 - 2:00
5 min

Closure. Discuss the following:

- New Game of the Week
- Remind participants to complete Weekly Log
- Distribute supplemental materials

4.2.4 Handouts

These handouts are needed during Session 2. The facilitator may want to make some of these into overhead projector foils for use during the inservice session.

Index to Handouts **Page**

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Using a Computer To Generate
and Test Hypotheses 3

Using a Database to Generate Hypotheses 8

Modifying a MS Works Database 12

Generating Hypotheses with a Paper Database 14

Game of the Week

Part 1: Database-Colored Glasses

Once you get your mind tuned to thinking about and looking for databases, you will find them nearly everywhere. The Game this week is to view the world through Database-Colored Glasses. Pretend that you are wearing glasses that add a special color or brilliance to anything that might be construed as a database. Maintain a list of all of the databases you encounter; for each, indicate one or more possible uses. Examples can run from the practical to the ludicrous. The idea is to generate as many instances as possible and increase your awareness of the practical applications as well as the off-beat possibilities.

Part 2: Databases in Science Textbooks

Collections of information (databases) are commonly used in science instruction. During the coming week examine a science textbook that you use frequently and locate two or three examples of databases.

Photocopy the databases and answer the following questions for each:

- Does the database use a form or list organization?
- How many fields does the database contain?
- Are there additional fields you would like in the database?
- How do you use this database in your science class?

Come prepared to share this information at the next session.

Activity 1

Using a Computer To Generate and Test Hypotheses

1. Turning on the computer and inserting the disks.

    - Reach behind the left side of the Macintosh and flip the power switch on.
    - Hold the **Microsoft *Works*** Program disk with the label up and insert the disk into the internal disk drive.
    - Hold the **Microsoft *Works*** Data disk with the label up and insert the disk into the external drive.

2. Selecting the desktop..

    Using the mouse, move the cursor over the **Explore Data** icon.

    - Click once on the mouse.

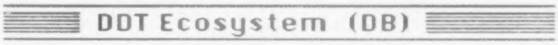
    A box will appear around the icon and title.

    - Click **Open** on the right side of the screen.

    Three small windows will appear on the screen: **DDT Ecosystem (DB)**, **DDT Concentration (SS)**, and **Vertebrates (DB)**.

3. Selecting and opening a file.

    - Click on the title bar of the **DDT Ecosystem (DB)**.



    - Click on the zoom box.

    The screen should now be entirely filled by the **DDT Ecosystem** database form. Notice the different types of information on the form.

4. **Form** organization of data.

    A database is similar to a library card catalog. Information about each book is stored on separate cards. The catalog is a collection of cards.

    In a database the individual cards are referred to as **forms.** On the screen is an example of data organized as a **form.**

    The information on one form is referred to as a **record.**

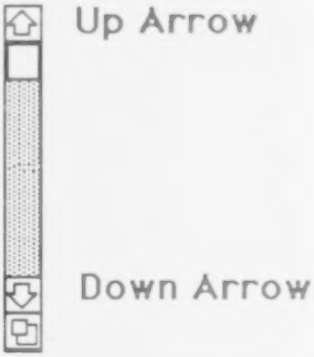
    - What does the information on this record describe?

The different types of information in the **record** are referred to as **fields**.

5. **Scrolling**

To view the forms one at a time:

- Locate the **vertical** scroll bar and move the **cursor** over the **down arrow** symbol (refer to the diagram).



- **Click once**. A new record should appear on the screen.
- Continue clicking on the mouse until you see a **blank** form. This blank form indicates you are at the end of the database.

Note: Be careful not to hold the mouse button down while scrolling.
The arrows are very sensitive and may cause you to miss records if you scroll too fast.

- How many records are in this database? ____________

To return to the beginning:

- Move the **cursor** over the **up arrow** symbol.
- Hold the mouse button down until you see the first record.
- Carefully examine the records to determine if there is a relationship between the **Concentration of DDT** and the **Role of Organism in Ecosystem.**
- Jot down your thoughts in the form of a question or a hypothesis.

____

____

____

- Think of other ways the information could be organized that might make it easier to see possible relationships. Jot down a few thoughts.

6. List organization of data.

Information in a database can also be organized as a **list**.

To see the information as a list

- Select **Show List** from the **Format** menu.

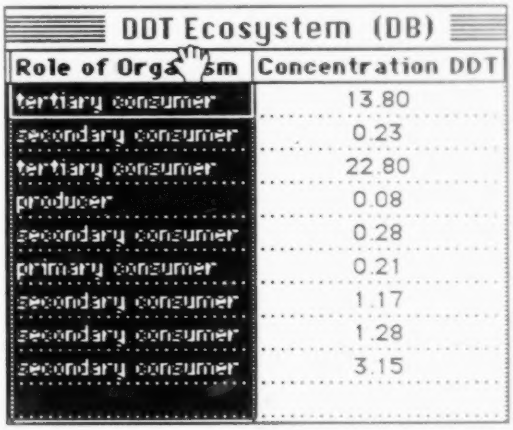
Scan the columns of information by moving the horizontal scroll box at the bottom of the screen, or by clicking the right and left arrows at the bottom of the screen.

7. Sorting Records.

Reorganizing the data may help you determine if there is a relationship between the **Concentration of DDT** and the **Role of Organism in Ecosystem**.

The computer can sort records in two ways: **alphabetically** or **numerically.** For example, to sort records alphabetically by the **Role of Organism in Ecosystem** field:

- Place the **cursor** on the heading (field title) **Role of Organism.**
- **Click** on the mouse. All entries in that column should be highlighted (refer to diagram given below).



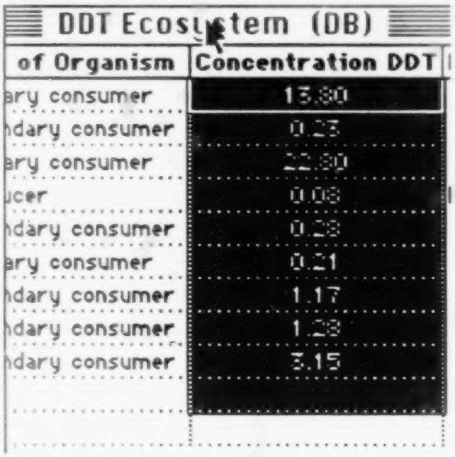
Role of Orga sm	Concentration DDT
tertiary consumer	13.80
secondary consumer	0.23
tertiary consumer	22.80
producer	0.08
secondary consumer	0.28
primary consumer	0.21
secondary consumer	1.17
secondary consumer	1.28
secondary consumer	3.15

- Select **Sort** from the **Organize** menu.
- Select from **"A to Z"** and click **OK**. (This causes alphabetical sorting starting at the beginning of the alphabet.

- Repeat the procedure in the **Common Name** field.

8. Sorting records **numerically.**

   - Select the **Concentration DDT** field.



DDT Ecosystem (DB)

of Organism	Concentration DDT
ary consumer	13.80
ndary consumer	0.23
ary consumer	22.80
ucer	0.08
ndary consumer	0.28
ary consumer	0.21
ndary consumer	1.17
ndary consumer	1.28
ndary consumer	3.15

   - Select **Sort** from the **Organize** menu.
   - Choose **"0 to 9" or "9 to 0"** and click **OK**.

Now the data is organized in either ascending (**"0 to 9"**) or descending (**"9 to 0"**) order according to DDT concentration.

   - Examine the data again to determine if there is a relationship between the **Concentration of DDT** and the **Role of Organism in Ecosystem.**
   - Write down the possible relationship in the form of a question or hypothesis.

____

____

   - Write down some ways of testing your hypothesis. Think of computer and non-computer methods.

9. Hypothesis testing using graphs

Data can be represented in visual formats such as tables, charts, and graphs. **Microsoft *Works*** has a graphing utility. However, it must be accessed through the spreadsheet.

To open a spreadsheet file:

- Click on the **Zoom** box.

The three small windows should now reappear on the screen.

- Select and open the **DDT Concentration (SS)** by double clicking on the title bar.

The spreadsheet contains data on **DDT concentration** and **Role of Organism in Ecosystem**.

A graph has been created to display this information.

- Select **Draw Chart** from the **Chart** menu.
- Click **OK**. The **Avg. DDT Concentration** graph should appear.
- Expand the **Avg. DDT Concentration** graph to the **Full Window**.

Is the graph format easier to interpret than the list? Explain.

Write down situations when you would represent data as a:

- form

- list

- graph

10. Closing the file.

- Click on the **Zoom** box.
- Click the **Close box** on the left end of the title bar of the DDT graph.

IMPORTANT — a dialog box may appear after you close each file, asking if you wish to save the changes to the file. Please answer **NO**.

- Click the **Close box** on the left end of the title bar of the **DDT Concentration (SS)** file. Do not save the changes.
- Click the **Close box** on the left end of the title bar of the **DDT Ecosystem (DB)** file. Do not save changes.

Activity 2

Using a Database to Generate Hypotheses

In this exercise you will use the **vertebrates** database from the Explore Data folder:

- to generate hypotheses and
- to sort and search the database to confirm or deny some hypotheses.

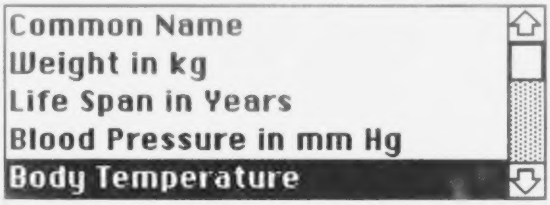
Part I

You may not know the meaning of the term **ambient**, but that just makes the activity more fun. Using the **select feature,** you will instruct the computer to pull out the records of vertebrates with an ambient body temperature. Use this information to generate a definition of the word **ambient**.

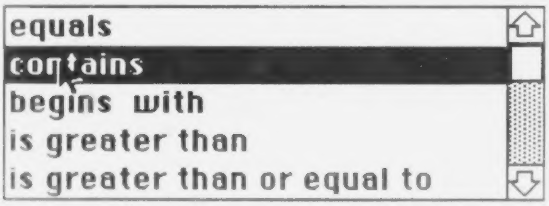
1. Selecting records from database.

   To have the computer **select** records with **Body Temperatures** recorded as **ambient**

   - Make sure the database is in the **List format** and that the **Common name** is visible.
   - Choose **Record Selection** from the **Organize** menu.
   - Select **Body Temperature** in the **Fields** option box on left. It should become highlighted.


Common Name
Weight in kg
Life Span in Years
Blood Pressure in mm Hg
Body Temperature

   - Select **contains** in **Rules** option box on right.


equals
contains
begins with
is greater than
is greater than or equal to

   A vertical line cursor is now blinking in the rectangular box after Record Comparison Information.

   - Type **ambient** in this rectangle.
   - Click **Install Rule** at bottom of screen.
   - Click the **Select** box at the bottom of the screen.

   You will now see records for vertebrates with ambient body temperatures.

Look at the **Class** field and note the types of vertebrates that have ambient body temperatures.

- Write down the names of these vertebrates.

Do the names of the vertebrates with ambient body temperatures suggest a definition of the term? Write down a definition that is suggested by the data you have available.

Part II

Selecting and sorting records might suggest additional hypotheses. For example, there may be a relationship between **the number of eggs or litter size of a vertebrate** and **the number of months** that a vertebrate cares for its young.

Before selecting the records, as a group come up with a hypothesis that might describe the relationship between the number of eggs or litter size of a vertebrate and the number of months vertebrates care for their young. Write it down.

____

____

____

1. Selecting and sorting records.

   To test your hypothesis you will select only those records that contain information about **egg or litter size** and **care of young**.

   - Select **Record Selection** in the **Organize** menu.
   - Delete both current rules by clicking the **Delete Rule** box twice. "No Rules Are In Effect" should appear after **Selection Rules**.
   - Use the arrows to scroll the field names until **Number of eggs or litter size** is visible.
   - Select **Number of eggs or litter size** from the **Fields** option box. Using the arrows to scroll, select **is not blank** from the **Rules** option box.
   - Click the **Install Rule** box.

- Select **And** under the Selection Rules.
- Select **Care of young** from the Fields option, then select **is not blank** from the **Rules** option box.
- Click the **Install Rule** box and then click the **Select** box at the bottom of the screen.

Using the records that have been selected, can you make a statement about the relationship between the number of eggs or litter size of a vertebrate and the length of time that vertebrate cares for its young?

It might be easier to form a hypothesis about this relationship if the records were organized in some manner.

- Sort the records according to the **Number of eggs or litter size field**.

Did selecting and sorting the records help confirm or deny your hypothesis? Use this space to write additional comments that occur to you.

Part III

Visually inspecting sorted records might suggest additional search criteria for selecting out records to look for relationships or to confirm or deny hypotheses. In the next example you will compare **Incubation Time in Days** and **Weight in kg**.

1. Sorting records **numerically.**

    - Select the **Incubation time in days** field.
    - Select **Sort** from the **Organize** menu.
    - Choose **"0 to 9"** and click **OK**.

    Make a note of any general patterns or trends.

    To help you form or test a hypothesis, select out the records of those vertebrates classified as Mammals.

    To **select** records:

- Select **Record Selection** in the **Organize** menu.
- Delete both current rules by clicking the **Delete Rule** box twice. "No Rules Are In Effect" should appear after **Selection Rules.**
- Use the arrows to scroll the field names until **Class** is visible.
- Select **Class** from the **Fields** option box.
- Select **contains** in the Rules option box on right.

A vertical line (cursor) is now blinking in the rectangular box after Record Comparison Information.

- Type **mammal** in this rectangle.
- Click the **Install Rule** box.
- Click **Select** at the bottom of the screen.

Do the selected records help you form, confirm, or deny a hypothesis? If not, suggest additional ways to search and sort the database that might help you .

Optional Activity
Modifying a MS Works Database

You may wish to modify a database by adding or deleting records and/or fields. The set of directions given below leads you through the steps to modify the Microsoft *Works* **Vertebrates** database you have been using in Session 2.

1. To add records to a database, select **Show Form** in the **Format** menu.

   - Scan to the last record by dragging the vertical scroll box all the way to the bottom. A blank record form should appear on the screen.

   - Select the data box beside **Common name**. It should become highlighted.

   - Type Alligator, and press **RETURN**. Notice the highlighted area automatically moves to the next field.

   - Enter the following data, pressing **RETURN** after each entry.
     Class - Reptilia
     Life span in years - 56
     Weight in kg - 226.96
     Number of chromosomes - 32
     Number of Eggs or Litter Size - 35
     Incubation time in days - 45
     Care of young in months - 0
     Blood pressure in mm Hg - **leave blank**
     Body temperature - Ambient
     Heart rate in BPM - 40

   - After the last data entry, a new blank record form automatically appears. Invent your own entries to be added to another record to the database.

   - To see if your new records are included in the list, select **Show list** from the Format menu. The new entries should appear at the end of the list.

2. You may also need to delete records from a database. To do this, scan the list to find the "**Human**" record. Select the small box to the left of "**Human**" by clicking on it. The entire "**Human**" row should become highlighted. Select **Cut** from the **Edit** menu.

   Describe the changes that take place within the list.

   You may wish to practice deleting other records in the same way.

3. You can also modify fields. To change a field name, select **Number of Eggs or Litter Size.** The entire data column should become highlighted. Then select **Change Field Name** from the **Edit** menu. Type **Offspring per breeding cycle**, and press **RETURN.**

   Note: It may be necessary to expand the width of the column to see the entire title. To do this place the cursor directly on the line between the "Offspring..." field and the field to the right of it. A line-shaped cursor (|) will appear. Hold the mouse button down, and "drag" the edge of the field to a wider position. Release the mouse button.

4. You can also delete a field. To do this select the **Life Span** field. The entire data column should become highlighted. Select **Delete Field** from the **Edit** menu.

   What changes take place within the list?

5. To add a field, select **Add New Field** from the **Edit** menu.

   - Type **Scientific Name** and press **RETURN.**
   - Find **Perch** in the **Common Name** column, and **select it**.
   - Select **Show Form** from the **Format** menu.
   - Select the data box to the right of **Scientific Name**. It should become highlighted.
   - Type **Perca fluviatilis** and press **RETURN**. You may need to expand the data box by placing the cursor directly on the end of the box (a | will appear). Hold the mouse button down, and "drag" the box to the desired width. Release the button.

If you have time, you may wish to **explore other possibilities**! The following are some optional suggestions you can try.

5A. To rearrange the fields within record forms, place the cursor on the field name (a hand will appear), hold the mouse button down, and "drag" the field to a new location. Release the mouse button.

Rearrange the fields to visually group the ones you feel are related. View other records by using the vertical scroll bar or the up/down arrows.

Does the new arrangement remain consistent for all of the records?

5B. A menu option is selected by clicking on it; a check will appear next to that option. To deselect an option, click to remove the check.

To change the visual effect of record forms, select and deselect combinations of bold characters and/or borders from the **Format** menu. (Note: Make sure you are in the Form format, before trying to change the record form.)

Which combination of record formats do you feel is clearest and easiest to read?

6. You can rearrange fields within records, add and delete fields and records, sort, search, manipulate, and examine as time allows.

Name: ____________________

Activity 3
Generating Hypotheses With a Paper Database

In this activity you will examine a **hard** (paper) **copy** of the **Vertebrate Database** to

- generate three hypotheses
- suggest how to search and sort the database to confirm or deny your hypotheses

Part I

Work with two or three other participants in the inservice. As a group, generate three hypotheses. Write them in the space provided.

1. ____

____

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2. ____

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3. ____

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Part II

Do this part of the activity working by yourself. After each member of your group has finished, compare and contrast results. For each hypothesis, explain how you could use searching and sorting capabilities with a database to help you confirm or deny the hypothesis. Write your testing strategies in the space below.

Hypothesis 1:

____

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15

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Hypothesis 2:

Hypothesis 3:

4.2.5 Student Materials

This Materials sections of the Notebook contains sample lesson plans and other materials designed for inservice participants to use with their students. The set of materials provided in this section is an off-machine activity. It helps illustrate the basic ideas of a database and can be used over a wide range of grade levels.

Index to Materials	Page
What's a Database?	1

What's a Database?

Description:

Topic: Understanding a database
Grade Level: 6 - 10
Time: 30 - 45 minutes

Grouping: whole class,
then 4 groups

Materials:

Software: None
Equipment: None
Other:
3 X 5 index cards
(3 for each student),
butcher paper (2 large sheets),
tape, markers

Objectives:
1. To understand the structure and format of a database by creating a data file and data table.
2. To gain insight into how a computer might facilitate sorting database information.

Before You Start:
1. Gather the materials.
2. Prepare a blank wall chart on the butcher paper. The number of horizontal spaces should be equal to the number of students in the class. Draw one vertical line, about six inches from the left edge of the paper, leaving enough room to enter the students' names in the leftmost column.
3. Label another blank piece of butcher.paper "FIELDS" and post it in a prominent place.

Lesson:
1. Present a brief, informal introduction by posing the question, "What is data?" Ask students how collections of data affect their lives, when collections of data might be useful to them, and what kinds of information they would like to know about their classmates.

2. After a few minutes of brainstorming, allow the students to record their suggestions of information categories on the "FIELDS" poster. Continue until there are 10 - 12 categories of information listed. Some possibilities include: Birth dates, favorite musical group, least favorite food and number of siblings.

3. At the same time, one student can be adding columns to the blank chart, and labeling each column with a new category suggestion. The chart should have a labeled column for each "FIELD" category listed on the poster.

4. Pass out three index cards to each student. They can begin filling in the cards with their names and data for each information category. Each student should make three identical index cards with their personal information.

5. After students fill out their cards, each one will fill in their name and the data on the large data chart.

6. When all data is entered (three identical cards for each student and the large data chart posted in the room) students divide into four groups. One group is designated as the "chart" group, while the other three are labeled as groups A, B, and C respectively. Groups A, B, and C move to corners of the room or other convenient locations where they cannot readily read the chart, while the chart group huddles near the chart. Each student gives one of his or her cards to each of the groups A, B, and C. Thus, each of the groups A, B, and C has a complete set of data on cards, while the chart group has the complete set of data on the chart.

7. Begin the **DATA RACE GAME**. The object of the game is to be the first group that correctly sorts through all of the records to match the "rules" given by the teacher.

8. Teacher reads selection rules aloud. Examples of rules might include: "Find all records for students who have birth dates in May and December." "Find all records for students whose last names contain the letter R." "Find all records for students who listed *Miami Vice* as their favorite TV show, OR who listed pizza as their favorite food."

9. Students use any method they wish to sort through cards or the list to arrive at the correct number of records. The first group to finish reads their list of student names for that selection rule while the other groups check for accuracy. Points may be awarded for both speed and accuracy.

10. The game continues at the teacher's discretion. Another challenge or "rule" might be to have the groups sort all records alphabetically by last name, or numerically by birth date.

11. Debrief. What were some of the problems of trying to sort data in this manner? What are some techniques students used to solve these problems? What are some tools that might be useful in solving these data sorting problems? Did the chart list or the collection of cards seem to be more useful for specific types of selection rules?

Post:

1. Use this activity to introduce vocabulary for computer databases: Record, Form, List, Search, Sort, Selection Rules, Fields, Instance, etc.

2. Enter the data into a computer database. Set up a station to allow students to sort, search, add more fields and records, etc. Let them make selection rule "challenges" for their classmates, using **AND/OR** connectors.

Comments: Jot down strong and weak points of the lesson and suggest changes for next time.

4.3

Session 3: Creating a Database for Testing Hypotheses

4.3.1 Narrative Overview

Session 3 provides participants their first opportunity to design and implement an electronic database. Session 3 objectives are to (a) provide participants guided practice in the skills necessary to construct databases, (b) familiarize participants with the CI^3 model for designing databases, and (c) demonstrate how to tie the construction of databases to the science curriculum and to the generation and testing of hypotheses.

As the designer and facilitator of a science inservice, you face a difficult task. It is relatively easy to design an inservice that "covers" a wide range of computer topics. But research strongly suggests that merely "covering" the topics contributes very little to actual teacher change in the classroom or to students getting a better education. The Session 3 as presented here "covers" a very important topic. If time permits, it is highly desirable that this session be expanded to allow the topic can be covered in adequate depth and breadth so there is a reasonable chance that the participants will begin to make use of topic ideas in their teaching. Some ideas on how to spend more time on this session's topic are provided later in this section.

Session 3 is composed of two activities. Activity 1 (Creating a Database) is an off-computer activity that guides participants throughout the planning and designing of a record template. Keep in mind that generally a database is designed to help answer certain questions or solve certain problems. The designer of the database must have a clear understanding of what types of questions and what types of problems will be addressed using the database. Participants are instructed to review the data sheet (Planet Characteristics) and determine questions or hypotheses they want to test using a database containing information on the planets. Once the questions have been generated, participants select fields for inclusion in the database. The final steps are designing the record template, and determining the data type (date, numeric, text, time) for each field.

In the debrief of Activity 1, make explicit the steps in the database design model (refer to Design Model). These include (a) selecting the data source, (b) formulating questions to be tested using the database, (c) designing the record template, and (d) constructing the database. Highlight the importance of determining how you want to use the database before actually building it. This is a key idea. A database is designed to answer or help answer a predetermined set of questions, or to help solve a predetermined set of problems. (Of course, frequently the database is also used to help answer questions or solve problems that were not anticipated when the database was being designed. This may be quite difficult to do in the relatively simple types of database systems used during this inservice. More sophisticated database systems are, in essence, relatively general purpose programming languages. With such a more sophisticated system it may be possible to write a program to restructure the database in order to help answer an unanticipated question.)

Activity 2 (Creating an Electronic Database) uses a structured guided discovery approach to enable participants to construct the planned database. Modifications to the guide sheet may be required, depending on your hardware and software resources. When making modifications, remember to continue to link database construction to the content and objectives of the your science curriculum.

Debriefing of Activity 2 should not occur until after participants have had time to use their databases. The testing phase points out flaws in the design process. Have participants volunteer how they would alter their original template designs and why. Emphasize the repetitive nature of this process (design, test, modification, test). Have participants discuss the similarities between database construction and design of scientific experiments. This cyclic approach is a key idea in solving problems. The relative ease of making changes via a computer lends itself to studying and practicing this approach to problem solving.

This week's Game of the Week actually serves as three Games of the Week. Thus, when you hand it out, indicate that it is to serve as the Game for Sessions 3, 4, and 5, and that it will require additional data collection and analysis work thereafter. Time needs to be provided during Session 4 and Session 5 to coordinate the work that participants have done during the preceding weeks. (Alternatively, a group of volunteers can do this work outside of the regular Session meeting times. If Session time is quite limited, this is a desirable alternative.)

The three-week Game of the Week activity demonstrates how databases can be integrated into the laboratory experience. The idea is to collect data, enter it into a database, and look for trends or patterns that suggest a relationship between weather conditions and a person's mood. The activity was suggested by a high school science teacher in our first pilot group. He had developed it and successfully used it with his students.

The specific activity of Session 3's Game of the Week is for participants to design a data collection sheet. Debrief the results of their work during Session 4. During week 4 participants are to develop a modified version of the data collection instrument based on ideas that are discussed during Session 4. They should try out their forms by collecting some data generated by themselves and a few students. In Session 5, use group consensus to develop a final version of the instrument. (Or allow each participant to develop his or her own final version of the form to be used. Be aware that when different scientists approach the same problem, they do not all approach it in the same way or achieve the same results.) The final instrument(s) can then be used by the participants and their students for data collection during the subsequent three weeks. It is appropriate to require participants during Session 8 to turn in summary statistics of the data that has been collected.

Pilot testing during the NSF project indicated this type of activity is an excellent way for participants to identify the characteristics of data that can be incorporated in a database. It also provided participants practice designing record templates to test a complex problem. Discussion of template design highlights the wide range of options possible depending on the hypotheses to be tested. This activity models how teachers in the context of experimentation can extend student's knowledge about databases and their limitations. It also models one technique for allowing students to conduct experiments where they are actively involved in the design and analysis of data. There is nothing cookbook about this approach.

Our pilot studies indicated that one two-hour session was not adequate to meet Session 3 objectives. We recommend a minimum of four two-hour sessions. The first session should focus on how to design a database and the skills required to implement it using the computer. End the session by familiarizing participants with the Database Sequence handout (30 minutes).

The addition of a second session does not required the development of new materials. This new session simply provides time for (a) additional instruction in implementing the database, (b) completion of the Creating an Electronic Database Activity, and (c) participants to use their newly constructed databases. This session should set aside 30 to 40 minutes for participants to share their hypotheses and testing strategies.

A third session provides time for teachers to design and implement a second database and related lesson plans for use in their classrooms. The goal is to provide participants practice so they feel comfortable working on their own. To accomplish this in two hours, have participants select their data, and design the record template prior to the inservice. (Note: Teachers should feel comfortable with the concept of a database and have mastered the basic skills necessary for constructing one before asking them to work on their own). Organize the session so the first half is for implementing the database and inputting the data. The remaining time should be unstructured to allow participants time to use their databases for hypotheses testing, and for obtaining additional help from inservice personnel.

If feasible, recruit participants willing to peer teach their lesson in a fourth and final session. The fourth session allows time for volunteer participants to try out their newly developed lessons in a simulated classroom situation (peer teaching). Videotaping the session for review and critique by the group is highly recommended.

4.3.2 Script

Theme

Designing and constructing databases to generate and test hypotheses.

Objectives

1. Provide guided practice designing databases.
2. Provide guided practice constructing databases.
3. Demonstrate using databases to conduct experiments.
4. Develop increased mastery in database operations.

Materials

Software	***Hardware***
Microsoft *Works*	Macintosh computers
Data disk	3 x 5 cards (one per participant)

Handouts

Activity 1 (Creating a Database to Test Hypotheses)
Activity 2 (Creating an Electronic Database to Test Hypotheses)
Game of the Week
Participant Log
Making A Database

Resources

overhead projector or white board
overhead marker or pens for white board
refreshments

Setup

Before participants arrive, have copies of Microsoft *Works* and the data disk at each computer. The computers will be turned off. By now the participants should be quite comfortable in booting up the computer system.

Introduction
10 minutes

Session 3 provides participants with a suggested model for introducing students to the use of databases in the context of generating and testing hypotheses. The session also provides participants a block of time to design and implement an electronic database. The facilitator should be aware that one two-hour session is insufficient to adequately learn the ideas of this session. Participants should be strongly encouraged to spend a reasonable amount of time during the week working on developing a functional level of skill in using the ideas of this session.

The first part of this session ties in well with the off-machine Activity 3 (Generating hypotheses with a Paper Database) from Session 2.

Activity 1
20 minutes

Creating a Database is an off-computer activity that models designing a database by first identifying the type of questions you want to answer. (The initial steps in designing a database are almost always done off the computer, either mentally or using pencil and paper. If good computer facilities are readily available, the next step is to pilot test the ideas, by developing a prototype on the computer.) Instruct participants to start constructing their database after completing this activity. Debrief the entire process following Activity 2.

Activity 2
20 minutes

Creating an Electronic Database is a structured guide sheet to enable participants to construct (implement) the planned database.

Hands on computer time demonstrates: (a) creating a file, (b) saving a file, (c) creating a record template, (d) template organization, (e) formatting fields, and (f) generating and testing hypotheses using a database.

Break
10 minutes

Break: Relax, mingle, refresh.

Debrief
15 minutes

Debrief Activities 1 and 2. Brainstorm with participants to develop a model for planning how to construct a database. Discuss how the type of questions or hypotheses to be tested influences the design of the database. Place particular emphasis on problem solving. A database is designed to help solve a specified category of problems or answer a specified category of questions. But there are always unanticipated problems and questions that can be addressed by a database. If the database is carefully designed, it may conveniently be used to address these unanticipated problems and questions.

Activity 3
30 minutes

Participants will develop testing strategies to confirm or deny their hypotheses. Allow enough time for participants to actually use their databases (play time).

Debrief
10 minutes

Ask participants to share their experience in using the database. Encourage participants to share flaws in their initial design. Did the design allow the hypotheses to be tested; how would they alter their original design? Emphasize the repetitive nature of the design process (design, test, modify, test). Have participants discuss the similarities between database construction and the design of scientific experiments.

Closure
5 minutes

Game of the Week

The objective of this week's game is to demonstrate how databases can be integrated into the laboratory experience. Participants will design a data collection sheet. This will be used to collect data to determine if there is any evidence to suggest a relationship between weather conditions and a person's mood. This project will take three weeks to get started, and then several weeks for data collection. It can serve as a major "term" project required of all participants.

Discuss the requirements for the final projects. The design of these final project activities may depend heavily on the level of science and computer sophistication of participants. Some participants may want to work in groups while others may want to work alone. In any case, the goal is participant involvement in a manner that increases the likelihood that they will actually transfer knowledge and skills from the inservice to their teaching.

The last session of this inservice series will be devoted to participants presenting their final projects, debriefing of the inservice series, and evaluation. Guests are welcome. Participants should make a major effort to get some of their fellow teachers and some of their school administrators to attend.

Think Ahead

Remind participants of the location of next week's session, and that the lab will remain open for one hour.

4.3.3 Timeline

Before participants arrive, have copies of the Microsoft *Works* and Data disks at the computers. Distribute Session 3 activity sheets as participants arrive.

0:00 - 0:10
10 min

Provide participants with time to execute the testing strategies developed in conjunction with Activity 3 (Generating hypotheses with a Paper Database) from Session 2.

0:10 - 0:15
5 min

Display the **Database Sequence** handout on an overhead. Recommend that participants use this model in developing materials that use databases for generating and testing of hypotheses. Encourage teachers to identify and describe potential problems they may run into when using the model.

Be prepared to offer suggestions on how to deal with the following:
- teaching database skills in the context of a science lesson
- use of peer tutors
- potential resources — computer teacher, commercial database software packages
- equipment related issues — lack of machines, use of large group demonstration, team teaching
- how all of this relates to teaching problem solving

0:15 - 1:00
45 min

Activity 1 and Activity 2: Participants will complete both activities before the debriefing occurs. Activity 1 instructs participants to examine the characteristics of the planets looking for patterns or general trends that suggest possible relationships. Each group will generate three hypotheses for future testing using a database they construct.

After generating the hypotheses, participants will design a record template using a three-by-five card. Upon completing the design phase, participants will move directly into Activity 2.

Activity 2 demonstrates:
- creating a file
- saving a file
- creating a record template
- template organization
- formatting fields
- hypothesis testing and confirmation

1:00 - 1:10
10 min

Break. Collect Weekly logs and Game of the Week.

1:10 - 1:25
15 min

Debrief Activity 1: Brainstorm with participants to develop a model for planning how to construct a database. Discuss how the type of questions or hypotheses you want to test using the database affect its design.

Debrief Game of the Week: Using chalk board or overhead, compile a list of databases participants currently use. Have participants discuss:
- if electronic versions of these databases would be useful as instructional tools

- ideas for converting paper databases into electronic ones
- databases that would be useful for a variety of subjects
- memorization versus having good "look it up" skills

1:25- 1:45
30 min

Participants will develop testing strategies to confirm or deny their hypotheses using the newly created databases.

1:45 - 2:00
15 min

Closure: Discuss the following:
Purpose and design of new Game of the Week

- designing an observation experiment
- Game will extent over several weeks
- modeling a purposed student activity

Discuss final projects. Some possible ideas for projects include:

- converting the planet information into an *AppleWorks* database
- developing a student handout for constructing a database using a different piece of software
- developing lesson plans to use with a particular database

Suggest

- that schools with enough participants might form two groups; one to set up a database and another to generate some activities and handouts using the database

Stress

- importance of sharing with other participants and fellow teachers the handouts and databases that are constructed

Invite guests, especially school administrators, to the final session when projects will be presented and curriculum implications of CII will be discussed.

4.3.4 Handouts

These handouts are needed during Session 3. The facilitator may want to make some of these into overhead projector foils for use during the inservice.

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Activity 1
Creating a Database

In this activity you will create a database to help you confirm or deny three hypotheses. This handout contains a chart that describes the following features for the planets in our solar system:

- position among planets
- mean distance from the sun
- rotation period
- period of revolution
- mean orbital velocity
- inclination of axis
- inclination of orbit
- eccentricity of orbit
- equatorial diameter
- diameter relative to earth
- mass
- mass relative to earth
- mean density
- gravity
- gravity relative to earth
- escape velocity at equator
- average surface temperature
- atmospheric pressure at equator
- main components of atmosphere
- planetary satellites

Using these fields, generate three hypotheses you would like to test with your database. Write them in the space below. You will then design a database that will help you to test these three hypotheses. It will contain only part of the data available to you.

1. ____

____

____

2. ____

____

____

3. ____

____

____

It is helpful to plan the format of each record before going to the computer. Take a note card and as a group decide the information on each planet you will include in your database.

Note: Each group must include one field in their database called **PLANET** which should contain the name of the planet.

	Earth	**Jupiter**	**Mars**
Position among planets	third	fifth	fourth
Mean Distance from sun	149,600,000 km 92,900,000 mi. 1 AU	778,300,000 km 483,300,000 mi. 5.202803 AU	227,900,000 km 141,500,000 mi. 1.523691 AU
Rotation Period	23 hr., 56 min., 4 sec	9 hr., 55 min., 30 sec.	24 hr., 37 min., 23 sec.
Period of Revolution	365.26 earth days	4,332.6 earth days	687 earth days
Mean Orbital Velocity	29.79 km/sec. 18.46 mi./sec.	13.06 km/sec. 8.1 mi./sec.	24.13 km/sec. 14.98 mi./sec.
Inclination of axis (in degrees and minutes)	23 27'	3 5'	25 12'
Inclination of orbit (in degrees)	0	1.3 (to ecliptic)	1.9
Eccentricity of orbit	0.017	0.048	0.093
Equatorial Diameter	12,756 km 7,921 mi.	143, 000 km 88,803 mi.	6,787 km 4,215 mi.
Diameter relative to earth	1.0	11.21 times	0.532 times
Mass	5.98×10^{24} kg 13.2×10^{24} lb.	1.899×10^{27} kg 4.187×10^{27} lb.	6.42×10^{23} kg 14.2×10^{23} lb.

	Earth	**Jupiter**	**Mars**
Mass relative to earth	1.0	317.9 times	0.1074 times
Mean Density	5.52 g/cm^3	1.314 g/cm^3	3.93 g/cm^3
Gravity (at the equator)	9.78 m/sec^2 32.1 ft./sec.^{2}	22.88 m/sec.^{2} 75.06 ft./sec.^{2}	3.72 m/sec.^{2} 12.2 ft./sec.^{2}
Gravity (relative to earth)	1.0	2.34	0.38
Escape Velocity at equator	11.2 km/sec. 6.96 mi./sec.	59.5 km/sec. 36.9 mi./sec.	5 km/sec. 3.1 mi./sec.
Average Surface temperature (in degrees)	288 K	165 K (1-bar level)	218 K
Atmospheric pressure at equator	1 bar	1 bar (apx.)	0.009 bar
Atmosphere (Main components)	Nitrogen 77 % Oxygen 21 % Water 1 % Argon .93 %	(near cloud tops) Hydrogen 90 % Helium ≈ 10 %	Carbon dioxide 95% Nitrogen 2.7 % Argon 1.6 %
Planetary Satellites	1 moon	16 moons	2 moons

	Mercury	**Neptune**	**Saturn**
Position among planets	first	eighth	sixth

Mean Distance from sun	57,900,000 km 35,960,000 mi. 0.387099 AU	4,497,000,000 km 2,793,000,000 mi. 30.0578 AU	1,472,000,000 km 914,000,000 mi. 9.53884 AU
Rotation Period	59 earth days	22 hr. (or less)	10 hr., 39 min., 20 sec.
Period of Revolution	88 earth days	60,189 earth days	10,759.2 earth days
Mean Orbital Velocity	47.89 km/sec. 29.7 mi./sec.	5.4 km/sec. 3.35 mi./sec.	9.64 km/sec. 5.99 mi./sec.
Inclination of axis (in degrees and minutes)	2°	28° 41'	26° 44'
Inclination of orbit (in degrees)	7	1.8	2.5
Eccentricity of orbit	0.206	0.009	0.056
Equatorial Diameter	4,880 km 3.030 mi.	49,500 km 30,739 mi.	120,000 km 74, 520 mi.
Diameter relative to earth	0.382 times	3.88 times	9.41 times
Mass	3.303×10^{23} kg 7.283×10^{23} lb.	1.030×10^{26} kg 2.271×10^{26} lb.	5.686×10^{26} kg 12.538×10^{26} lb.
	Mercury	**Neptune**	**Saturn**
Mass relative to earth	0.0558 times	17.23 times	95.2 times

Mean Density	5.42 g/cm^3	1.8 g/cm^3	0.69 g/cm^3
Gravity (at the equator)	3.78 m/sec.^{2} 12.4 ft./sec.^{2}	11 m/sec$\cdot^2$ 36 ft./sec.^{2}	9.05 m/sec.^{2} 29.69 ft./sec.^{2}
Gravity (relative to earth)	0.38	1.12	0.92
Escape Velocity at equator	4.3 km/sec. 2.7 mi./sec.	23.6 km/sec. 14.66 mi./sec.	35.6 km/sec. 22.1 mi./sec.
Average surface Temperature(in degrees)	440 K	43 K (1-bar level)	140 K
Atmospheric pressure at surface	10^{-15} bars	N.A.	1bar (apx.)
Atmosphere (Main components)	Virtually none (of that, Helium .98, Hydrogen .02)	Hydrogen Helium Methane	Hydrogen 94 % Helium ≈ 6 %
Planetary Satellites	none	2 moons	15 moons

	Uranus	Venus	Pluto
Position among planets	seventh	second	ninth
Mean Distance from sun	2,870,000,000 km 1,782,000,000 mi. 19.189 AU	108,200,000 km 67,200,000 mi. 0.723332 AU	5,900,000,000 km 3,664,000,000 mi. 39.44 AU
Rotation Period	- 23.9 hr. (retrograde)	- 243.01 earth days(retrograde)	6 days, 9 hr., 18 min. (retrograde)

Period of Revolution	30,685.4 earth days	224.7 earth days	90,465 earth days
Mean Orbital Velocity	6.8 km/sec. 4.2 mi./sec.	35.03 km/sec. 21.75 mi./sec.	4.7 km/sec. 2.9 mi./sec.
Inclination of axis(in degrees and minutes)	97° 55'	3°	60° (?)
Inclination of orbit(in degrees)	0.8	3.39	17.2
Eccentricity of orbit	0.047	0.007	0.25
Equatorial Diameter	51,800 km 32,168 mi.	12,104 km 7,517 mi.	3,500 km (?) 2,173 mi.
Diameter relative to earth	4.1 times	0.949 times	≈ 0.27 (?)

	Uranus	**Venus**	**Pluto**
Mass	8.66×10^{25} kg 19.09×10^{25} lb.	4.87×10^{24} kg 10.7×10^{24} lb.	$\approx 6.6 \times 10^{21}$ kg $\approx 14.5 \times 10^{21}$ lb.
Mass relative to earth	14.6 times	0.815	≈ 0.0017 times
Mean Density	≈ 1.2 g/cm^3	5.24 g/cm^3	≈ 0.7 g/cm^3
Gravity (at the equator)	7.77 m/sec.^{2} 25.5 ft./sec.^{2}	8.60 m/sec.^{2} 28.2 ft./sec.^{2}	≈ 4.3 m/sec.^{2} ≈ 14.1 ft./sec.^{2}

Gravity (relative to earth)	0.79	0.88	0.43
Escape Velocity at equator	21.2 km/sec. 13.2 mi./sec.	10.3 km/sec. 6.40 mi./sec.	5.3 km/sec. 3.29 mi./sec.
Average surface temperature (in degrees)	(cloud tops) 58 K	730 K	≈ 0 K
Atmospheric pressure at equator or surface	N.A.	90 bars	0.1 millibar (?)
Atmosphere (Main components)	Hydrogen Helium Methane	Carbon dioxide 96 % Nitrogen 3.5 %	tenuous methane and possibly neon
Planetary Satellites	5 moons	None	1 moon

Bunch, B. (1984). *The Science Almanac* (1985-1986 Edition). Garden City, NY: Anchor Books.

Activity 2

Creating an Electronic Database

Note: These directions are for Microsoft *Works* Version 1.0.

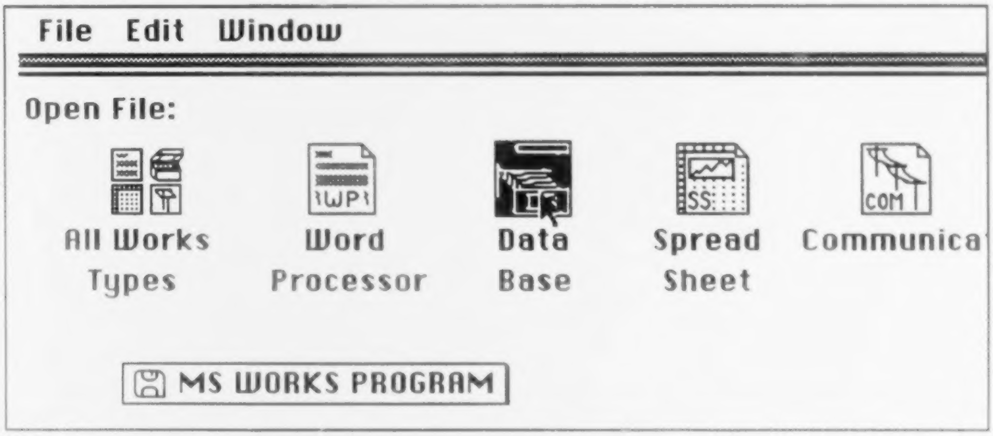
1. To start insert the

    - **Microsoft *Works* Program disk** in the internal drive
    - **Microsoft *Works* Data disk** in the external drive.

    Note: Remember to click on the **drive** box until the **Mini-finder** screen displays the following icons: **Microsoft Wo..., Mammal File..., Fish Files, Explore Spr..., Kinematics, Explore Data, and Energy Balance.**

2. To create a new file:

    - Select the **Microsoft Wo..** icon.
    - Click on **Open** on the right side of the screen.
    - Select the **database icon** (see figure below).


File
Edit
Window
Open File:
All Works Types
Word Processor
Data Base
Spread Sheet
Communica
MS WORKS PROGRAM

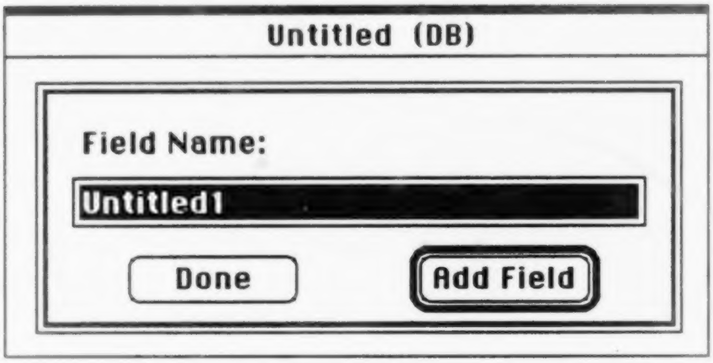
    - Click on the **NEW** box (bottom right of the dialog box).

3. Entering field names.

    Note: If you make a mistake while entering a field name, just continue without trying to fix it. It is easier to edit after all the field names have been entered.

    To enter a field name:

    - **Type** in the field name when you see the **Field name** box.



Field Name: Untitled1

The word **Untitled1** will be replaced by the field name.

- Click on the **Add Field** box ***or*** press the **RETURN** key.

Continue to add field names until all the fields have been entered, then

- Click on the **Done** box.

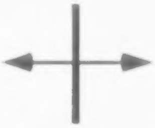
To change a field name:

- **Select** the field to be edited.
- Select **Change Field Name...** from the **Edit** menu. The Field Name box should appear on the screen.
- Put the cursor in the rectangle behind the field name.
- **Click** once. This should deselect the field name.
- Back space to erase, and type in the correction.

4. Changing characteristics of fields in form format.

To expand the length of the data box of a field:

- Place the cursor directly over the end of the data box.
  An I-beam should appear.



- Hold the mouse button down and **drag** the mouse to expand the box.
- **Release** the button when the size looks correct.

Practice expanding other field boxes.

5. Arranging fields on database form.

You may wish to reposition the fields to group categories of related data. To do this

- Move the **cursor** over the field name. A hand should appear.
- Hold down the mouse button and **drag** the field to a new location.
- Release the button.

6. Setting field attributes.

A **field attribute** tells the computer what type of data to accept in each category. There are 4 data types: **text, numeric, date,** and **time**. The field containing the names of the planets is an example of text.

To set the field attributes:

- Select a field.
- Pull down the **Format** menu
- Select **Set Field Attributes ...**
- Select the appropriate **Type.** For example if the field contains numeric data you may select various types of **Display**, **Alignment**, or **Style**.

Note: The computer automatically displays numeric data with two places to the right of the decimal point. You may wish to change this.

When you have finished selecting data attributes for a field:

- Click on the **OK** box.

Note: You can double click on the data box (next to the field name) to set the field attributes. This is somewhat faster than using the **Format** menu for each field.

Set the attributes for all the fields.

6. Entering data.

Data can be entered in either the form or list format. Usually data is entered using the form because it shows all the fields on the screen. However, if there are only a few fields it may be easier to enter the data using the list format.

In this exercise, enter data using the form. To enter data:

- **Click** on the the data box of the topmost field. The data box should become highlighted.
- Type in the data from the keyboard. The data will appear at the top of the screen in the edit bar as you type.
- Press **TAB**. The data will appear in the data box.

The next field automatically becomes highlighted. Continue to enter data as the fields become highlighted. To select any field, click on its data box. Continue entering data until all fields have been entered.

A blank form will appear when all the data for a given record has been entered. Continue adding information until all the data for the nine planets has been entered.

7. Changing the appearance of records.

You might like to change the appearance of the records in the database. To see the options available:

- Pull down the **Format** menu.

Several options are available: bold field names, bold field data, border field names, and border field data.

To select any of these features

- Select a feature and release the mouse button. A check will appear by the option when is has been selected.
- Select several options.

If you do not like a change, it is easy to change back. To **deselect** an option

- Select the option a second time. The check should disappear, and the appearance of the record form should change.

Choose the combination of options you feel make the information easy to read.

8. Show List Format

To see how the information looks as a list:

- Select **Show list** from the **Format** menu.
- **Move** through the database using the horizontal scroll bar.

9. Changing field size in list format.

To increase or decrease the width of fields:

- Place the cursor on the lines between the field names. An I-beam should appear.
- Holding the mouse button down move the mouse until the width is correct, then release the button.

10. Moving fields

Practice rearranging the order of the fields:

- **Click** on the heading of a field. The entire field should become highlighted.

- Holding the mouse button down, drag the field to a new location and release the button.

Look at the database in both the form and list format to make sure all fields and the data in them are clearly visible and grouped to help students see patterns or trends.

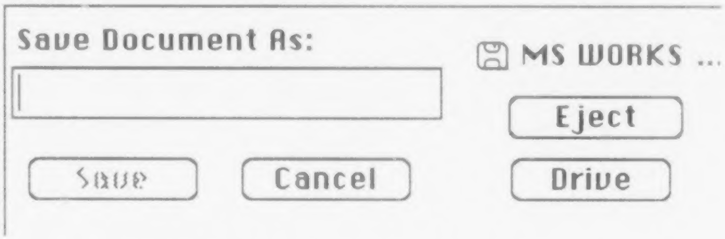
11. Saving the file.

When you are satisfied with the organization of the database, you will want to make a permanent record of it. To save the file

- Select **Save As...** from the **File** menu.

- Click on the **Drive** box. **MS WORKS DATA** should appear at the top.

Enter a name for the database. The name you enter will appear as you type, and will replace **Untitled** as the document name.



- Click on the **Save** box to save the database on the data disk.

Name: ______________________

Game of the Week

For this week and the next two weeks, the Game of the Week will relate to designing an experiment to determine if there is a relationship between the weather and a person's mood. Notice that you will need to develop measurable definitions of both "weather" and "mood." You should think about developing definitions that students can follow with reasonable consistency. Once the definitions and appropriate data collection forms have been developed, you will use them with some of your students for several weeks. You will be expected to turn in summary statistics and a brief written report on this project at the last inservice session.

Your assignment this week is to design a one page form (8 1/2 by 11) to record daily observations of a person's mood and the weather. Please be prepared to share at the next session. Make enough copies so that each person in the inservice, including the facilitator, can have a copy. This is the type of activity that does not have a single "correct" answer. You may want to engage your students in developing suitable answers. After all, the goal is to develop forms that they can use. As you get ideas, try them out on your students. This is called pilot testing.

Preparation for Final Project Presentations

All participants are required to take part in group presentations at the eighth and final session. Each group will turn in a short written description of the project one week before the final session. It is assumed that all members of a group will make a significant contribution to the work of the group.

- Each presentation will be a maximum of 10 minutes long.
- Each presentation will be followed by a short debriefing involving all inservice participants and guests.
- Please make 25 copies of any handouts used in the presentation.

If you create a database or spreadsheet, please share it with the other participants. Blank disks will be available at the last session so you may copy participant produced databases and spreadsheets.

4.3.5 Student Materials

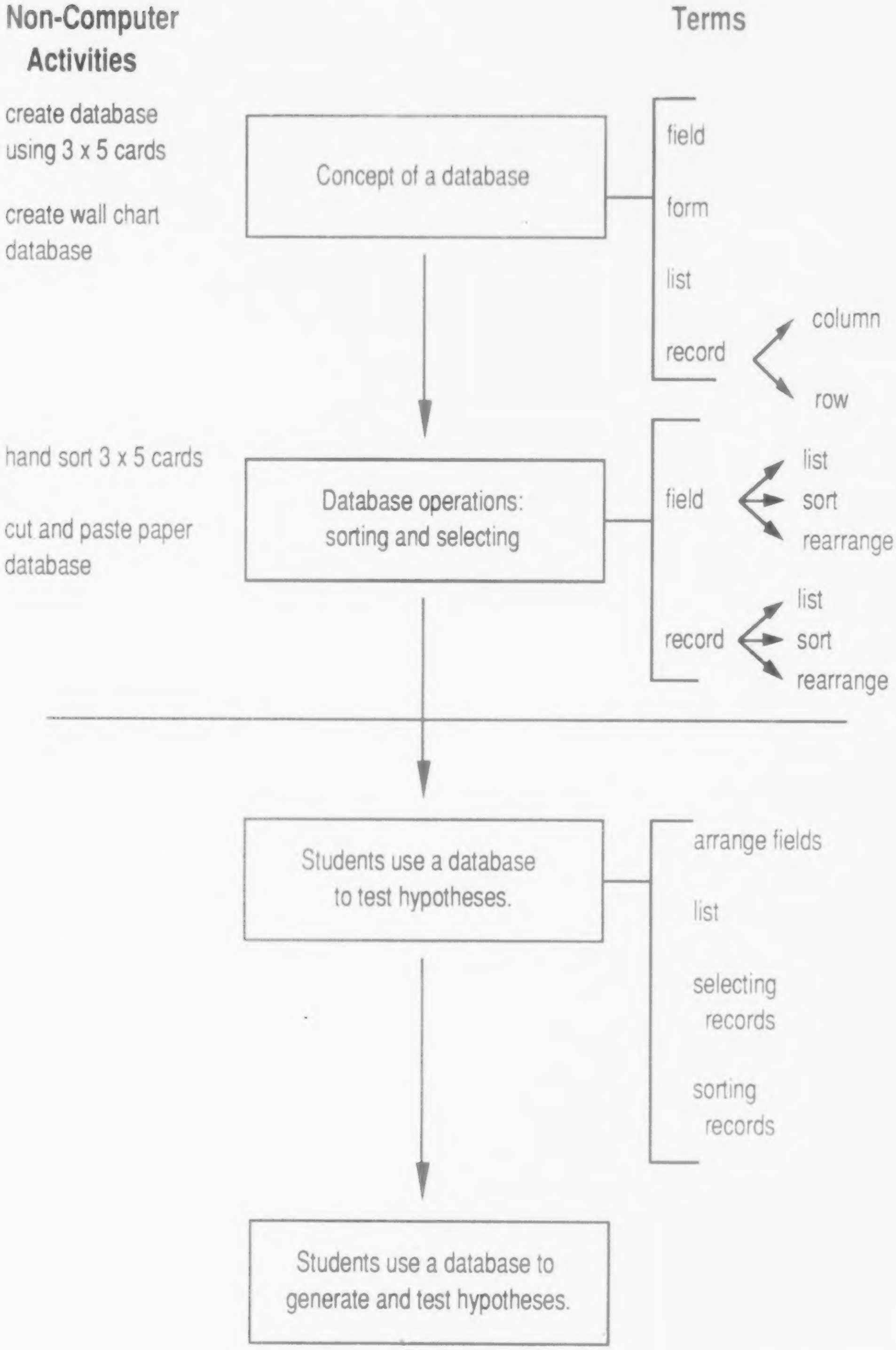
This Materials sections of the Notebook contains sample lesson plans and other materials designed for inservice participants to use with their students.

Index to Materials **Page**

Database Sequence 2

Making a Database: An Off Machine Activity 3

Database Sequence


Non-Computer Activities
Terms
create database using 3 x 5 cards
create wall chart database
Concept of a database
field
form
list
record
column
row
hand sort 3 x 5 cards
cut and paste paper database
Database operations: sorting and selecting
field
list
sort
rearrange
record
list
sort
rearrange
Students use a database to test hypotheses.
arrange fields
list
selecting records
sorting records
Students use a database to generate and test hypotheses.

Making a Database: An Off-Machine Activity

Description:
Topic: Creating and using a database
Grade level: 6-10

Time: 30 - 45 minutes, 2 days
Grouping: Whole groups then small groups of 2-3.
Objectives:
1) To practice organizing data into a data file and data table.
2) To practice selecting specific records to test hypotheses.

Materials:
Software: none
Equipment: none

Other: reference books
2 large sheets butcher paper
index cards — 1 per student
marking pens
card file box

Before you start:

1. Gather the materials.
2. Prepare a blank wall chart on the butcher paper. The number of horizontal spaces should be equal to the number of students in the class. Draw 6-10 vertical columns, leaving sufficient room to write in column headings.
3. Post the chart in a prominent place.
4. Post the other blank sheet in a prominent place.

Lesson:

Day 1

1. Introduce the activity in the context of a unit or general topic area the students are currently studying. Elicit the main topic area from the students (i.e., "The Solar System") and then allow them to generate specific subjects within that topic (i.e., planet names, moons, the sun, etc.).

2. As the students generate specific subjects, those subjects should be entered in the left-most column on the blank wall chart.

3. Discuss what kinds of information might be interesting or useful to know about these specific subjects. These can be generated as questions, then condensed to one or two word titles.

4. Enter the information titles in the vertical columns across the top of the blank wall chart.

5. Help students decide on a consistent way to record this information on their index cards. When a format is agreed upon, model this on the blank sheet of butcher paper by writing the field names in the appropriate location.

6. Each student chooses one of the specific subjects. In small groups or pairs, students are to use reference books to find the information they need to record on the index card following the model format.

7. When the students are through entering the data on their index cards, they can enter their data on the large information chart.

Day 2

1. Introduce the lesson by explaining that scientists generally tend to look for patterns or trends, then try to form generalizations to explain these. A generalization, or hypothesis, should then be tested to see if it really holds true in all known cases. Note that this can also suggest the need to find new cases.

2. Direct the students' attention to the large data table. Brainstorm any patterns that might show relationships between the categories of information. Lead the students to form hypotheses (i.e., the larger the planet, the slower its orbital speed). Generate 5-8 hypotheses.

3. Using the tables or the collection of index cards in the file, students work in small groups to "test" these hypotheses. Each hypothesis should be examined and the group should decide if they agree with the hypothesis. If not, state the "exception" that causes them to disagree, and try to generate a new hypothesis.

4. Debrief with the entire class, having each group state whether they agreed or disagreed with each hypothesis and why. Discussion/debate should ensue, with possibilities for new hypotheses being generated.

Post

Create a computerized database. Set up a station to allow students to sort, search, add more fields and records, and so forth. Let them list hypotheses to be tested with the sorting and selection capabilities of the database application.

Comments

Jot down strong and weak points of the lesson. Suggest changes and extensions. This general lesson plan could be used several times in a course.

4.4

Session 4: Introduction to Hypothesis Testing Using Spreadsheets

4.4.1 Narrative Overview

Session 4 has two goals: 1) to gradually reduce participant dependence on detailed training aids, and 2) to demonstrate how spreadsheets can be used to generate and test "what if" questions.

The general approach to hands-on activities used in these inservice sessions is working in pairs. Generally speaking, this works well, and both participants using a machine gain the desired knowledge and skills. However, there is a danger that a few participants will let their partners do all of the work. Before using Session 4 materials it is important to determine, either formally or informally, if all participants are comfortable with basic computer operations. These include turning the computer on and off, booting up the Microsoft *Works* software, using databases from a disk file, and simple file operations (opening, closing, modifying, saving changes). Such an assessment may reveal which participants require additional help before using the materials developed for this session.

One difference between a typical inservice and a university class now becomes apparent. In a university class, you would feel free to give a "test" in which students had to take a data disk and Microsoft Works, go to a computer, start up the system, accomplish specified tasks, shut down the computer system, and turn in the results. Most inservices do not have such formal testing. Research strongly suggests that teachers participating in inservices do not like to be placed in such testing situations.

A database and a spreadsheet are relatively similar data structures. In their simplest forms, each is a rectangular array of cells. Each generally contains provisions for rearranging rows or columns, inserting new rows or columns, and deleting rows or columns. A spreadsheet contains provisions for doing arithmetic on specified rows or columns. It contains provisions for inputting formulas that specify what arithmetic is to be done. In the early history of computer databases, the database software generally did not contain provisions for doing arithmetic on the data. However, some database programs now provide these capabilities.

The version of Microsoft *Works* used in these inservices has relatively limited mathematical graphing capabilities, and these are designed to work with data given in a spreadsheet. Thus, if one wants to graph data that is in a database, it must first be moved to a spreadsheet. This was a design decision on the part of the software developers. Some database programs contain graphing capabilities. For example, the program *FrEdBase* (this is freeware designed to run on the Apple II series of computers, distributed by California CUE and by ISTE) contains graphing capabilities.

A spreadsheet is a very powerful piece of software. It was originally designed to be used in business. The rows and columns of a spreadsheet resemble the accounting forms that are commonly used in business. Many of the problems that commonly occur in business can be modeled using a spreadsheet program. Relatively complicated business problems can be solved using this tool.

As spreadsheet software became commonly available, it soon became evident that there were also many problems outside of business that could be attacked through use of this software. Now many junior high school computer literacy courses contain a unit on spreadsheets. It is appropriate to teach use of spreadsheets in science and math classes, as well as in business classes.

Activity 1 (Using Spreadsheets to Generate and Test Hypotheses) uses a structured guided discovery approach to demonstrate how to use a spreadsheet to make and test predications (hypotheses). Participants predict the relationship between two quantities (mass and weight) and use the spreadsheet to test their predictions. Mass and weight were selected because of their common occurrence in the middle and secondary curriculum, and because teachers should feel comfortable predicting a relationship between the two. Remember, you want teachers to focus on how to use spreadsheets to generate and test hypotheses, not on content expertise.

Note that the issue of focusing on science content versus computer content comes up over and over again as one does a computer inservice for science teachers. It is essential that the inservice facilitator be highly competent both in science and in the computer field. At each stage of the inservice a careful decision needs to be made on how much focus to place on the computer content and how much on the science content. This is highly dependent on the science competence of the participants.

The debriefing session should focus on how using spreadsheets to answer "what if" questions provides teachers with a new method of experimentation in their science curriculum. Spreadsheets allow participants to make predications, test predications, and receive immediate feedback without the overhead of mathematical calculations.

The piloting of the materials in this session revealed that some participants may have reservations about using spreadsheets with students whose mathematical skills are low. The reservations are similar to those concerning the use of calculators or electronic graphing (i.e., students must have developed mastery of the skill before using the technological aid). It is important for participants to have time to express these concerns. Take on the role of facilitator and record keeper during the discussion, but allow participants to struggle with this issue by themselves.

It may be worth noting that the mathematics education leadership in the United States (working through the National Council of Teachers of Mathematics) have strongly supported use of calculators in schools since the late 1970s. They argue that a substantial part of the mathematics education emphasis on by-hand calculations should be replaced by use of calculators, more emphasis on mental estimation, and more emphasis on problem solving. Moreover, at the college level, students in science and engineering classes are generally allowed to use calculators whenever they please, including during tests.

As the facilitator you may wish to introduce or refer participants to Seymour Papert's argument that if student's see the need and/or an application for knowledge they will be more willing to develop the skill (*Mindstorms*, 1980). As record keeper, record the types of students and the teaching situations for whom participants think the use of spreadsheets is appropriate. This information can be very valuable when participants start to develop their own materials.

Activity 2 (Microsoft *Works* Graphing Introduction) and Activity 3 (Microsoft *Works* Printing) are examples of training aids designed to develop teacher mastery (and later on student mastery) using the graphing and printing component of Microsoft *Works*. Please note that mastery is taught in the context of hypothesis testing and that one activity is not sufficient to develop it. Depending on your software resources you may wish to devote an entire session to an electronic graphing package (there are a number of commercially available graphics packages designed for use by scientists). The key to developing mastery is to provide teachers enough time to practice and feel comfortable using the software before expecting them to integrate it into their classroom instruction.

During the previous week participants have been working on designing definitions and data collection forms for a study on weather and moods. Each participants was to prepare a one page handout to be shared with all other participants. To continue this activity, ask participants to take these handouts, develop definitions and data collection forms they feel are suitable, and field test them with some of their students. They are to bring to the next inservice session multiple copies of the definitions and data collection forms that they have developed, and a brief written discussion of some of the features of their work that they consider particularly good. These will be shared among all participants and be used for still another round of revision.

During the National Science Foundation pilot testing of the materials in this Notebook, a formative evaluation was performed at the end of Session 4. A sample of the instrument used is included in Part 5 of this book. It is designed to take between 15 and 20 minutes to administer.

4.4.2 Script

Theme

Using spreadsheets to generate and test hypotheses.

Objectives

1. Demonstrate how a spreadsheet can be used to facilitate generating and testing of hypotheses (predictions).
2. Demonstrate how a spreadsheet can be used to practice the following skills:
   - graphing data
   - developing formulas to express mathematical relationships
   - sorting data in ascending or descending order
   - generating and testing predications

Materials

Software	***Hardware***
Microsoft *Works* Program disk	Macintosh computers with
Microsoft *Works* Data disk	one printer per 3-4 computers

Handouts
Using Spreadsheets to Test Hypotheses
Microsoft *Works* Graphing Introduction
Microsoft *Works* Printing Introduction
Microsoft *Works* Graphing Help Sheet
Spreadsheets in the Classroom: Part I
Spreadsheets in the Classroom: Part II
Participant Log
Game of the Week

Resources

overhead projector
overhead markers
refreshments
Science Skill transparency

Setup

Before participants arrive have copies of Microsoft Works™ and the data disk at each computer. The computers will be turned off. By now participants should feel very comfortable starting up a Macintosh computer system.

Introduction

The materials for this session assume no previous experience with spreadsheets. The materials are not intended to develop participant mastery in the design or implementation of a spreadsheet or in specific spreadsheet operations. The primary goal is to develop positive teacher attitudes about using spreadsheets for the generation and testing of hypotheses with all ability level students.

A spreadsheet is a computer tool designed to make it relatively easy to develop mathematical models for certain types of problems. While problem solving is stressed in science, not all science teachers are good problem solvers. Similarly, while modeling is a key aspect of science, not all science teachers have a good understanding of modeling. They do not recognize that a formula such as distance = rate x time or $E = mc^2$ is a mathematical model. Thus, some participants will be encountering the need to learn about spreadsheets simultaneously with learning more about problem solving and modeling. This difficulty should be openly addressed and discussed. Mathematical modeling is a key aspect of science!

Activity I
30 minutes

Activity 1: Using Spreadsheets to Generate and Test Hypotheses demonstrates a process approach to science using the computer. The activity models how to use a spreadsheet to: 1) generate a hypothesis to describe the relationship between weight and mass, 2) sort data to test hypothesis, and 3) predict what would happen to the weight of an object if there was a change in the force of gravity. In this activity, participants are building a mathematical model, a spreadsheet, to investigate an important problem in science.

Debrief
15 minutes

This introduction to use of a spreadsheet focuses on solving a particular problem rather than on learning to use a spreadsheet. This is a key idea throughout the CI^3 project inservices. Computer software is getting easier to learn and easier to use, but problem solving remains difficult. Thus, the emphasis in a hands-on inservice should be on problem solving rather than on details of using a specific piece of software. The idea here is to role model such instructional behavior and make sure that participants understand that they also should begin to adopt such behavior in working with their own students.

Break
10 minutes

Make sure that Ballistic (SS) is left on the desktop before the start of Activity 2.

Activity 2
40 minutes

Activity 2: Microsoft *Works* Graphing Introduction uses a structured approach to demonstrate how electronic graphing can be used to generate and test a hypotheses. Because of the structured guided approach, the activity allows students without previous computer experience to construct a hypothesis using the graphing tool of Microsoft *Works*.

Once again it is important to clearly differentiate between learning the "key press sequences" needed to accomplish specific tasks (such as to graph data) and understanding what problems one can solve using the computer tool. It is relatively easy to learn key press sequences; and besides, it is easy to have a performance aid available. It is much harder to learn to solve problems using the computer tool. Thus, much of the instructional emphasis needs to be placed on the use of the computer tool in problem solving.

Activity 3
10 minutes

The purpose of this activity is to allow participants to print out the graphs produced by the computer in the previous exercise. This is an optional activity. It can be completed by participants after the session if they have access to computers.

Debrief
10 minutes

What type of graph is most appropriate for a particular type of data? Is there some easy way to tell when to use a pie chart, or when to use a bar graph? For example, a pie chart is a "parts of a whole" type of graph. It is most appropriately used when some quantity (such as a 24 hour day) is being divided into pieces, and you want to make visually clear the relative sizes of the pieces.

Closure
5 minutes

If the formative evaluation instrument is to be administered, the closure will take about 25 minutes.

Game of

As appropriate, debrief last weeks' Game. Make sure that each participant gets a

Game of the Week	As appropriate, debrief last weeks' Game. Make sure that each participant gets a copy of the one-page handout that each participant was to prepare during the week. Indicate that this type of pooling of ideas and feedback cycles can be quite helpful in developing definitions and information collection forms that are to be used by a wide variety of people.
Formative Evaluation	If a formative evaluation is to be performed, provide time at the end of the session. The instrument given in Part 5 of this book takes about 15-20 minutes to administer.
Final Project	Check to see if participants have questions about their final projects. They should be working on the projects in a systematic manner, rather than leaving the work until the last minute.

The International Society for Technology in Education (ISTE) publishes a spreadsheet-like piece of software called Formula Vision. It is an inexpensive and excellent aid to introducing science students to the idea of mathematical modeling in a spreadsheet environment. The software is very easy to learn how to use. If time permits, it would be appropriate to devote about a half of a session to Formula Vision. This activity requires access to Apple II or MS-DOS compatible computers.

4.4.3 Timeline

Before participants arrive have the Microsoft *Works* Program disk and the Data disk at each computer. Machines will be turned off.

0:00 - 0:30 30 min	Activity 1: Using Spreadsheets to Generate and Test Hypotheses. Participants working in groups will complete Activity 1, which demonstrates the following spreadsheet features: • sorting • automatic recalculation
0:30 - 0:45 15 min	Debrief Activity 1. What did they learn? What level or type of student would benefit most from an activity like this?
0:45 - 0:55 10 min	Break. Collect logs and check to make sure Ballistic (SS) is the only file on the desktop.
0:55 - 1:35 40 min	Activity 2. Microsoft *Works* Graphing Introduction. Participants working in pairs will complete Activity 2.
1:35 - 1:45 10 min	Activity 3. Microsoft *Works* Printing Introduction. This is an optional activity. Some participants may need additional time to complete Activity 2.
1:45 - 2:00 15 min	Closure. Debrief Activity 2. If a formative evaluation is to be done, delete Activity 3 and shorten Activity 2 by about five minutes. The formative evaluation form takes about 20 minutes to complete. Briefly discuss the ongoing Game of the Week. Make sure that each participant gets a copy of the one page handout that each participant was to prepare. Remind participants of the location of the next meeting and to fill in their log sheets. Keep the room open for an hour for anyone who wants additional time. Suggest that if participants want to do Activity 3, this extra hour of computer lab access would be a good time to do it.

4.4.4 Handouts

These handouts are needed during Session 4. The facilitator may want to make some of these into overhead projector foils for use during the inservice.

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Microsoft *Works* Printing Introduction 13

Microsoft *Works* Graphing Help Sheet 14

Game of the Week 15

Activity 1

Using Spreadsheets to Generate and Test Hypotheses

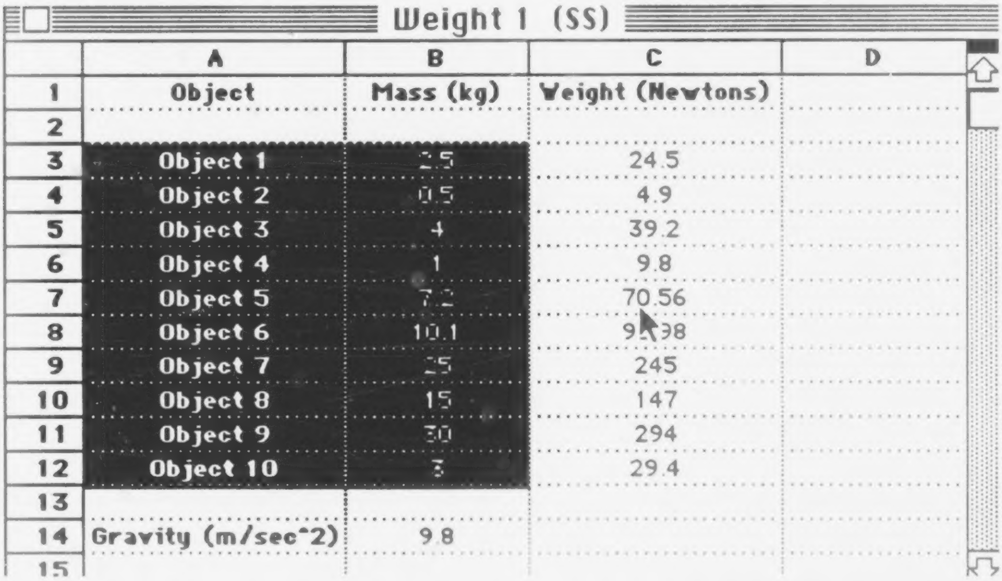
1. Inserting the disks.
    - **Microsoft *Works*** Program disk into the internal drive
    - **Microsoft *Works*** Data disk into the external drive
2. Selecting the external drive.
    - Use the mouse to move the cursor over the **Drive** box on the right side of the screen.
3. Selecting the desktop.
    - Select the **Explore Spr...** by clicking on it once. A box will appear around the **icon and title.**
    - Click **Open** on the right side of the screen.

   Two windows will appear on the screen: **Weight 1** (SS) and **Ballistic** (SS).
4. Expanding to a full window.
    - Double click on the title bar of the **Weight 1 (SS)** to expand to full window.
5. **Spreadsheets** can be used to see relationships that may help us to generate hypotheses. For example, reorganizing the data the in **Weight 1 (SS)** may help us generate a hypothesis describing the relationship between the **weight** of an object and its **mass**.

   One way to reorganize the data is to sort the objects by mass. Sorting in a spreadsheet is **different** from sorting in a database. When you sort in a database on one column, all other columns are automatically "carried along" in their correct, sorted order. That is, all of the records are reordered to correspond to the sorting on the specified field. But that is not the case with the sort facility in the Microsoft Works spreadsheet. With the Microsoft Works spreadsheet you must **sort all** the columns of data at the same time, to keep the data in column A associated with the appropriate data in columns **B** and C. (Be careful — you can easily mess up your spreadsheet data. Keep a backup copy of the spreadsheet. Notice that this is different than sorting in a database.)

   To sort the data according to the **mass** of the objects:
    - Select cell **A3** by clicking on it.
    - Holding the mouse button down, drag the cursor across **Column A and B** and down until **Objects 1** through **Object 10** and **their masses** are highlighted. Do not select the title of either **Column A** or **Column B.** Your screen should look like the following diagram.

Note: If you the screen does not look like the following diagram, deselect (click once) and try again.



Weight 1 (SS)

	A	B	C	D
1	Object	Mass (kg)	Weight (Newtons)	
2				
3	Object 1	2.5	24.5	
4	Object 2	0.5	4.9	
5	Object 3	4	39.2	
6	Object 4	1	9.8	
7	Object 5	7.2	70.56	
8	Object 6	10.1	9[illegible]98	
9	Object 7	25	245	
10	Object 8	15	147	
11	Object 9	30	294	
12	Object 10	3	29.4	
13				
14	Gravity (m/sec^2)	9.8		
15				

- Release the mouse button.

Note: There is no need to arrange **column C.** The values are the result of calculations using the contents of **columns A and B**. The spreadsheet automatically recalculates **Column C** following the sorting.

To sort:

- Select **Sort** from the **Edit** menu. A dialog box will appear.
- Type in the letter **B.** It will replace the value in the **1st Key Column.**
- **Sort** in either ascending or descending order by clicking on the appropriate circle.
- When you are ready to sort click on the **OK** box.
- Examine the data and write down a hypothesis to describe the relationship between mass and weight.

Hypothesis: ______________________________

____

6. Hypothesis testing using a spreadsheet.

- Select **Show Formulas** from the **Options Menu.**

- Look at the weight column.

Notice that Weight of the object is calculated by multiplying the mass of an object times the acceleration due to gravity. In this example all weights are calculated on the earth where the acceleration due to gravity equals **9.8 m/sec^2**.

- Predict what would happen to the weight of any object if the acceleration due to gravity were changed.

  Hypothesis: ____

  ____

To test your hypothesis:

- Select **Show Values** from the **Options Menu.** This allows you to observe changes in the weight values.
- Select cell **B14.**
- Type in a new value and press return.

7. Another test of how gravity is related to the weight of an object is to observe how the weight of one object is affected as gravity changes.

- Choose an object to experiment with. Enter its number in the chart below.
- Select **Show Values** from the **Options Menu.**
- Select cell **B14.**
- Type in the acceleration due to gravity on *Jupiter* (refer to following chart) and press return.
- In the chart write down the weight of the object when gravity equals 22.88.
- Repeat the procedure and complete the following chart.

Object Number : ____________

Planet	**Surface Gravity (m/sec^2)**	**Weight (Newtons)**
Jupiter	22.88	__________
Venus	8.60	__________
Pluto	4.3	__________
Mars	3.72	__________

Do the changes in gravity help you confirm or deny your hypothesis about the effect of gravity on the weight of an object? _______

Did this experiment provide you with new information that can be used to expand your previous hypothesis? If so write a new hypothesis.

8. Closing the file.

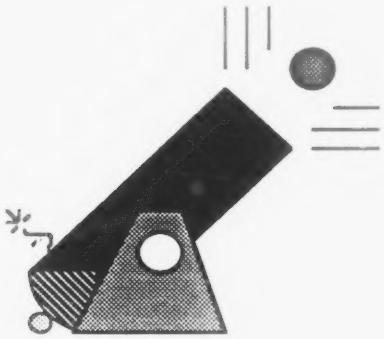
    - Close the **Weight 1 (SS)** by clicking on the **Close** box on the left end of the title bar.

Important: A **dialog box** may appear after you close the window, asking if you wish to save the changes to the file. Please answer **No**.

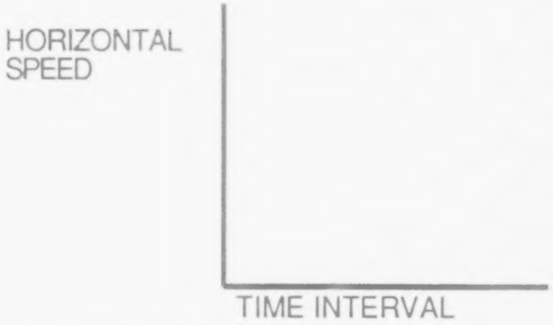
Activity 2
Microsoft *Works* Graphing Introduction

1. Graphing data is another method to represent data so that one can generate hypotheses.

In this example, graphs are used to help us generate a hypothesis to predict the path of a cannonball shot out of a cannon.



The first two graphs we will generate plot the horizontal and vertical speed of the cannonball against time. Notice that we are using "time" as the horizontal axis in both cases.



- Double click on the **title bar** of the **Ballistic** (SS) to get a full window view.

The data in **Row 4** describes the horizontal velocity of the object at different time intervals. The time intervals are recorded in **Row 7**. The data runs from column **B to M.** A graph of the data has been set up in the software, ready to be viewed. To view the graph:

- Select **Draw Chart** from the **Chart menu**.

- Select **Hori. Velocity 1** and click on the **OK** box.
- Examine the graph.
- Describe the horizontal velocity of the cannonball. If possible include a numeric value in your description.

  ____

  ____

- Write down a hypothesis that predicts the horizontal velocity of the object over time.

  Hypothesis: ______________________________________

  ____

- Return to the spreadsheet by clicking on the close box of the **Hori Velocity 1** graph.

2. We want to determine if a *larger initial velocity* affects the *horizontal velocity* of the cannon ball as it leaves the cannon. By substituting a new value for the **initial velocity** and graphing the motion, we can experiment with different initial velocities.

   To enter a new initial velocity:

   - Select **C12.**
   - Type in a new value and Press **RETURN.** The new value should appear in **C12**. The computer will automatically recalculate the horizontal velocity.

   To view the graph:

   - Select **Draw Chart** from the **Chart** menu.
   - Select **Hori. Velocity 1** and click on the **OK** box.

   Note: The computer automatically redraws the graph based on the new initial velocity.

   - Describe any change in the horizontal velocity of the cannon ball because of a change in the initial velocity.

     ____

     ____

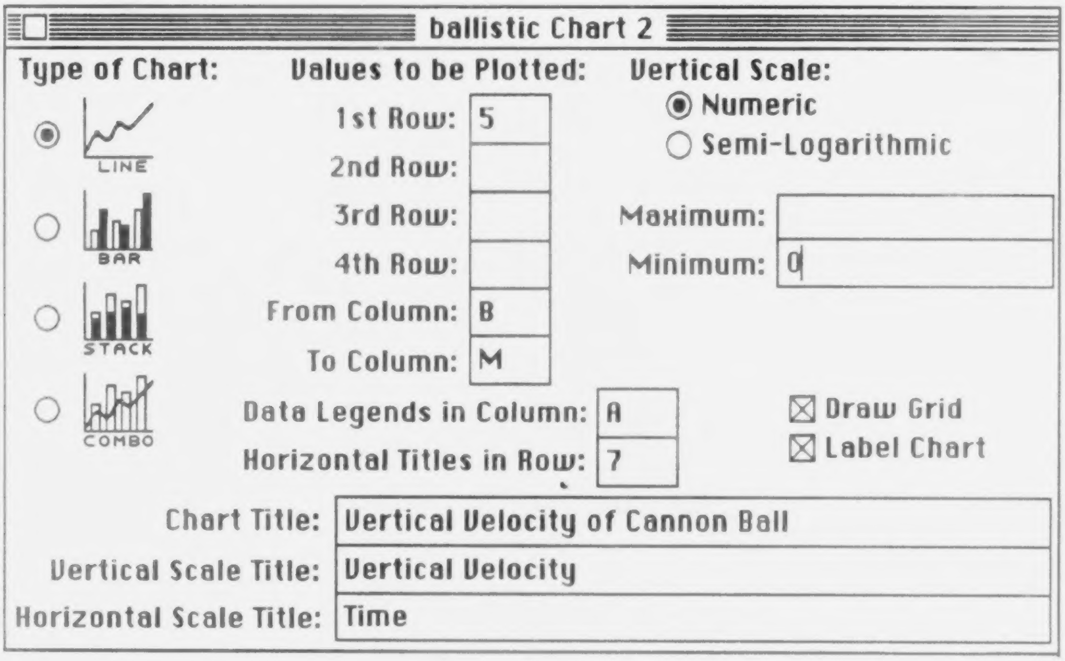
   - Does the new graph change your description of the horizontal velocity of an object over time?
   - Close the **Horizontal Velocity** graph window.

3. You will construct a graph of the cannonball's *vertical velocity* vs. *time* to help you describe the vertical motion of the cannonball.

The data in **Row 5** of the spreadsheet describes the *vertical velocity* of the cannon ball at different time intervals. The data in **Row 7** describes the time intervals. The data runs from **column B to M**. To graph the vertical velocity:

- Select **New Series Chart** from the **Chart** menu. Enter the values as indicated in the figure given below.

Note: At the end of the activity is a *Graphing Help Sheet*. Please take it out and refer to it for a detailed explanation of the individual components in the **New Series Chart** window.



ballistic Chart 2

Type of Chart:
● LINE
○ BAR
○ STACK
○ COMBO

Values to be Plotted:
1st Row: 5
2nd Row:
3rd Row:
4th Row:
From Column: B
To Column: M
Data Legends in Column: A
Horizontal Titles in Row: 7

Vertical Scale:
● Numeric
○ Semi-Logarithmic
Maximum:
Minimum: 0

☒ Draw Grid
☒ Label Chart

Chart Title: Vertical Velocity of Cannon Ball
Vertical Scale Title: Vertical Velocity
Horizontal Scale Title: Time

- Click in the **Plot It!** box when you are ready to see the graph.
- Examine the graph; write down a hypothesis that describes the vertical velocity of the cannon ball.

Hypothesis: ____

____

- Click on the close box to return to the **Ballistics** spreadsheet.

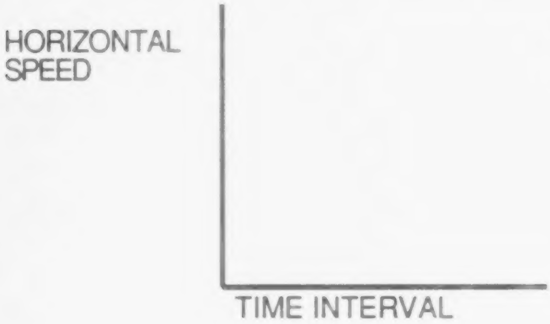
4. The previous graphs broke the motion of the cannon ball into two separate components:

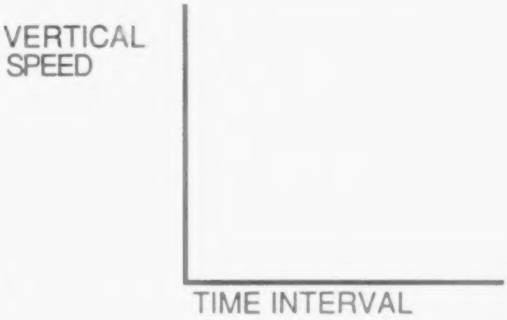
- the horizontal motion of the cannon ball

  and

- the vertical motion of the cannon ball

Use the grid below to sketch the *horizontal velocity* graph and the *vertical velocity graph*.





5. Setting up a graph.

Looking at the two motions on the same graph may provide additional information to describe the actual motion of the cannonball.

To graph:

- Note the row numbers of the data to be plotted:

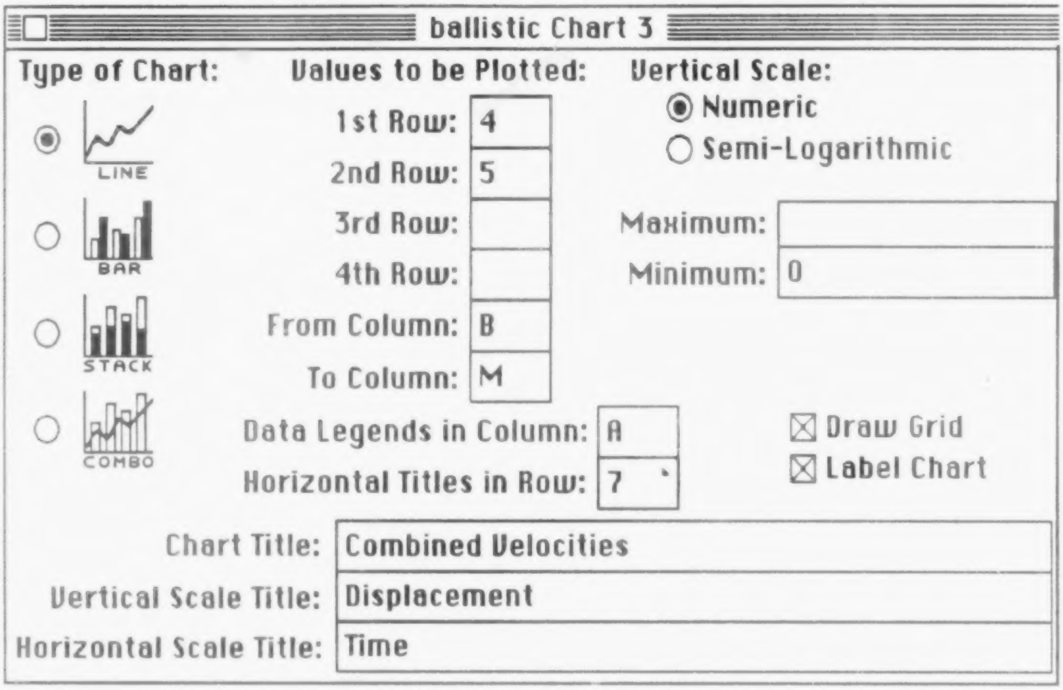
  - Horizontal Velocity row number ___________

  - Vertical Velocity row number ___________

Keep in mind that the data runs from **column B to column M**.

- Select **New Series Chart** from **Chart** menu.

- Enter the values as indicated on the *next page*. If you have trouble, remember to refer to the Graphing Help Sheet.



ballistic Chart 3

Type of Chart:

- ● LINE
- ○ BAR
- ○ STACK
- ○ COMBO

Values to be Plotted:

1st Row: 4
2nd Row: 5
3rd Row:
4th Row:
From Column: B
To Column: M
Data Legends in Column: A
Horizontal Titles in Row: 7

Vertical Scale:

- ● Numeric
- ○ Semi-Logarithmic

Maximum:
Minimum: 0

☒ Draw Grid
☒ Label Chart

Chart Title: Combined Velocities
Vertical Scale Title: Displacement
Horizontal Scale Title: Time

- When ready **Plot it!**

6. The previous graphs represent the horizontal and vertical motion of the cannonball as independent actions. The actual path of the cannonball is a combination of the two. It can be described by plotting the vertical displacement vs the horizontal displacement. Remember displacement (distance moved) is a result of an object's velocity.

- Return to the spreadsheet.

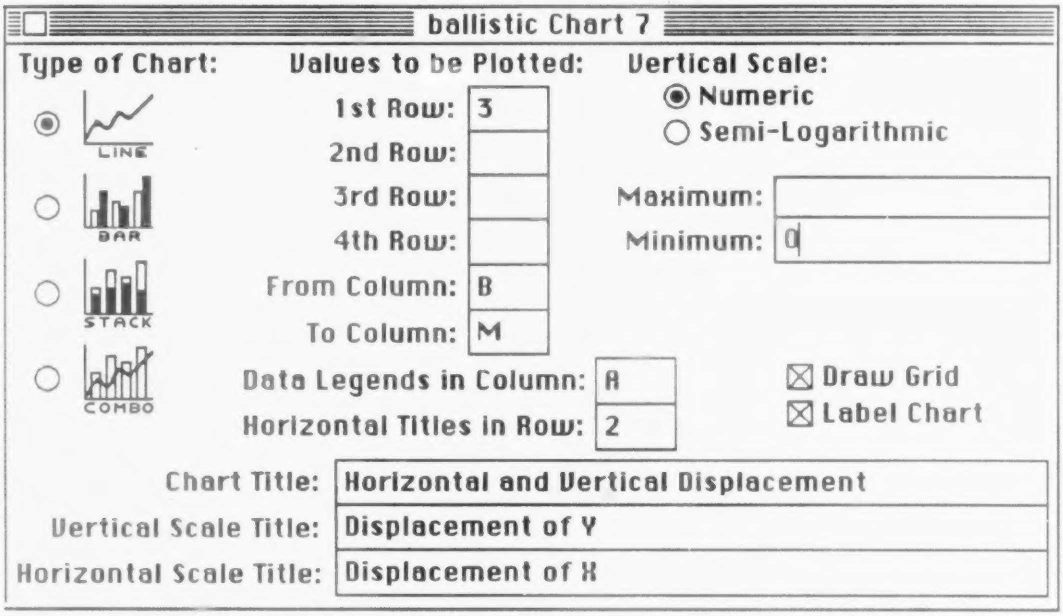
Important Note: Everyone will use the *same value* for the *initial velocity* and *initial angle* of the cannonball.

To verify that you values are correct:

- Select **C12.**
- If the value is ***not* 110**, type in 110 followed by a return.
- Select **C13**.
- If the value is ***not* 45**, type in 45 followed by a return. To construct the graph:
- Note the row numbers of the data to be plotted:

  - Horizontal Displacement row number ____________
  - Vertical Displacement row number ____________

- Select **New Series Chart** from **Chart** menu. Enter the values as indicated :



ballistic Chart 7

Type of Chart:
● LINE
○ BAR
○ STACK
○ COMBO

Values to be Plotted:
1st Row: 3
2nd Row:
3rd Row:
4th Row:
From Column: B
To Column: M
Data Legends in Column: A
Horizontal Titles in Row: 2

Vertical Scale:
● Numeric
○ Semi-Logarithmic
Maximum:
Minimum: 0

☒ Draw Grid
☒ Label Chart

Chart Title: Horizontal and Vertical Displacement
Vertical Scale Title: Displacement of Y
Horizontal Scale Title: Displacement of X

- When ready **Plot it!**

7. Now its time to explore on your own. Make predictions that describe the path of the cannon ball as the values of the following variables are altered: *Y acceleration* (acceleration due to gravity); *initial velocity and initial angle; length of the time interval.*

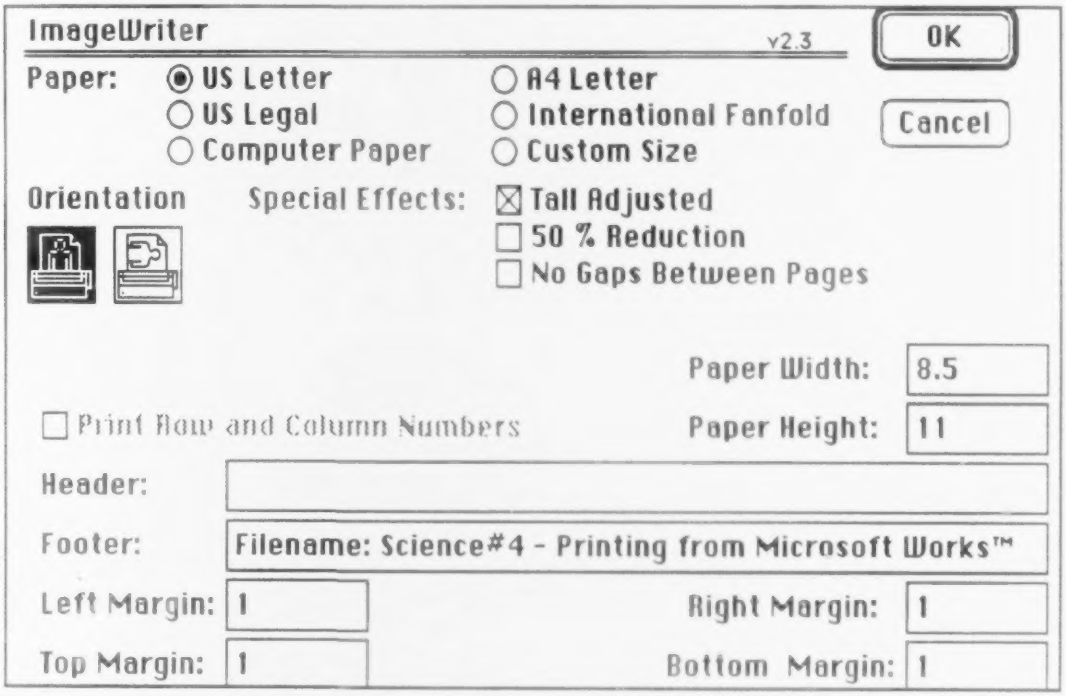
   Try graphing the data to confirm or deny your hypothesis.

Activity 3
Microsoft *Works* Printing Introduction

Note: This activity requires a computer that is attached to a printer. These computers are identified with signs. Please move to one of those computers before attempting the activity.

1. Printing Microsoft *Works* files.

- Click on the title bar of the **Weight 1** (SS).
- Expand to a full window.
- Select **Page Setup...** from the **File** Menu. The following dialog box will appear.



Paper: ● US Letter ○ A4 Letter ○ US Legal ○ International Fanfold ○ Computer Paper ○ Custom Size

Special Effects: ☒ Tall Adjusted ☐ 50 % Reduction ☐ No Gaps Between Pages

Paper Width: 8.5

☐ Print Row and Column Numbers

Paper Height: 11

Header:

Footer: Filename: Science#4 - Printing from Microsoft Works™

Left Margin: 1

Right Margin: 1

Top Margin: 1

Bottom Margin: 1

- Locate the **Orientation Box** in the window.
- Move the cursor (arrow) over the **second** box (left) under the word **Orientation**.
- Click on the mouse.
- Click on the **OK** box. The dialog box should close.
- Select **Print** from the **file** menu. A dialog box will appear instructing you how to stop (cancel) the print.

2. Printing spreadsheet files.

   Large spreadsheets will not fit on one sheet of computer paper. Often people do a (by-hand) cut and paste job to put the pieces of a spreadsheet printout into an easily readable form.

3. Printing graphs.

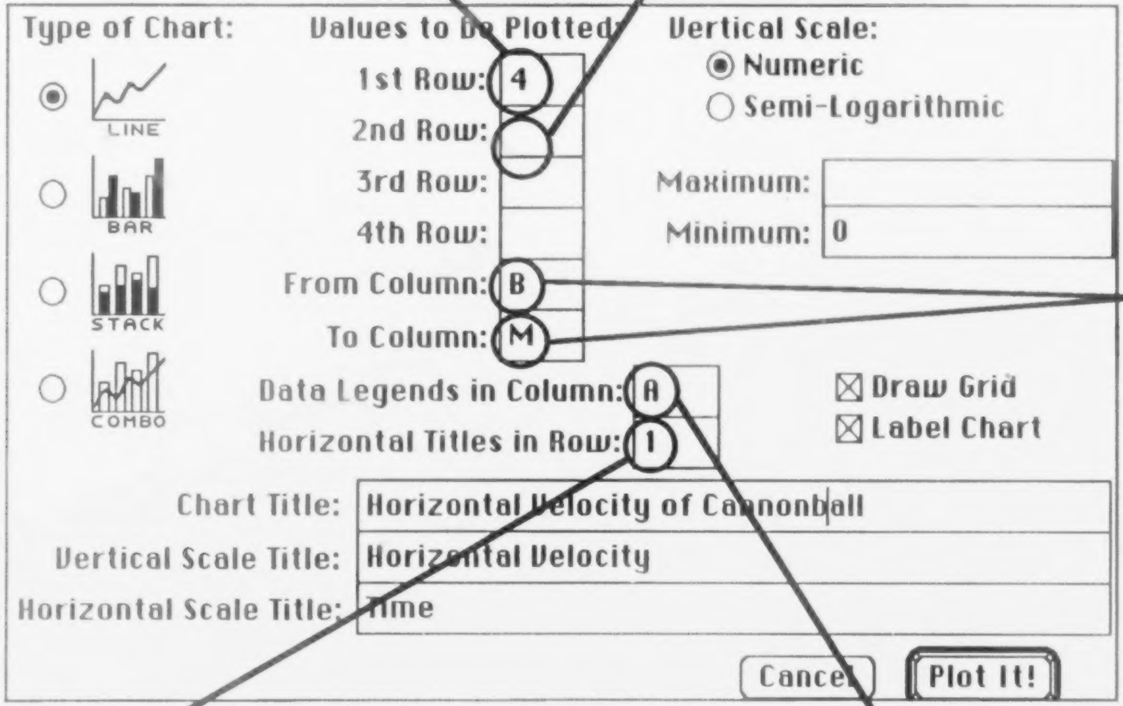
   - Select **Draw Chart** from the **Chart** menu.
   - Click on the **title bar** of the graph to be printed.
   - Click the **OK** box. The graph should appear on the screen.
   - Select **Print Window** from the File menu. The computer should print the active window.

   Practice printing one of the graphs used in the activity or the **Ballistic (SS)** spreadsheet.

Microsoft *Works* Graphing Help Sheet

Enter the ROW number for data that will appear on the Y axis.

If you were graphing more than one piece of information on the same graph (i.e., the movement of 2 objects of different masses) the ROW number of the second list of data would be entered here.



Type of Chart:
● LINE
○ BAR
○ STACK
○ COMBO

Values to be Plotted:
1st Row: 4
2nd Row:
3rd Row:
4th Row:
From Column: B
To Column: M
Data Legends in Column: A
Horizontal Titles in Row: 1

Vertical Scale:
● Numeric
○ Semi-Logarithmic

Maximum:
Minimum: 0

☒ Draw Grid
☒ Label Chart

Chart Title: Horizontal Velocity of Cannonball
Vertical Scale Title: Horizontal Velocity
Horizontal Scale Title: Time

These indicate the beginning and ending columns for the data that will be plotted on Y axis.

Enter the ROW number of the data to be plotted on the X axis.

This indicates the column where the headings for your data can be found (i.e., if Weight is a heading, what column does the word Weight occur in?)

Game of the Week

Beginning in Session 3 and continuing through Sessions 4 and 5, the Game of the Week relates to designing an experiment to determine if there is a relationship between the weather and a person's mood. This requires the development of measurable definitions of both "weather" and "mood." The goal is to develop definitions that students can follow with reasonable consistency. Once the definitions and appropriate data collection forms have been developed, you will use them with some of your students for several weeks. You will be expected to turn in summary statistics and a brief written report on this project at the last inservice session.

Your assignment this week is to redesign your one-page form (8 1/2 by 11) to record daily observations of a person's mood and the weather, and try it out with a few students. Then write a brief report that emphasizes the best and most important features of your work. You want to convince other participants in the inservice that your ideas are important and must be included in the final definitions and data collection forms that they and you are developing. Please be prepared to share at the next session. Make enough copies so that each person in the inservice, including the facilitator, can have one.

4.4.5 Student Materials

This Materials sections of the Notebook contains sample lesson plans and other materials designed for inservice participants to use with their students. This particular section contains materials from a two-article series that was originally published in *The Computing Teacher*. We have done a slight reorganization of the two-article series to make it more convenient for the reader.

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Spreadsheets in the Classroom: Part I

by

Joan Marie Brown

[Joan Marie Brown, University of Michigan — Dearborn, The Mall 1094, MI 48128.]

(Reprinted with permission from the *The Computing Teacher*, December/January, 1986-87.)

Good activities make it easier to introduce and teach spreadsheets to secondary students. Joan Brown presents two such lessons here, and two more will follow in next month's issue.

Introduction

A spreadsheet program is a large on-screen computerized worksheet, resembling a chart or a ledger sheet. It's made up of many rows and many columns with thousands of cells. It's an electronic chart in which mathematical data can be organized and manipulated. And it's a decision-making tool, helping the user both define problems and experiment with different solutions.

There are several reasons for using a spreadsheet program with your students.

1. It encourages logical thinking.
2. It promotes organizational skills.
3. It encourages problem solving skills.
4. It sets the stage for experimentation.
5. It enables students to view a problem in general as well as in specific terms.
6. It makes algebraic concepts concrete.
7. It gives students a new interest in math.
8. It familiarizes students with a real-life business tool.
9. It encourages student-adult interaction.
10. It's fun!

Teaching a spreadsheet program to a roomful of students can be a real challenge. Such a program is difficult to teach; it also can be a frustrating one to learn. The experience, however, is rewarding for everyone involved when the spreadsheet is introduced as a problem solving tool.

The "spreadsheet challenge" can be broken down into teachable, learnable parts. I have developed four individual lesson plans to use when introducing a spreadsheet program to high school or college students. Two appear on these pages, and two more will appear next month.

I haven't assigned a time frame to any of these lesson plans. The time needed will vary as students progress at different speeds. It might take anywhere from one to four class hours to teach each lesson, depending on your school's scheduling procedures, how comfortable you feel with the material, and how well your students are grasping the information.

LESSON ONE: BEFORE SPREADSHEETS

OBJECTIVE: To demonstrate how to manage mathematical data using a chart or a ledger sheet.

EQUIPMENT: Overhead.

PREPARATION: Photocopy the worksheet on pages 6-7 for each student and make one transparency of the Chart.

ACTIVITIES:

1. Assign the GRADES learning activity. You should fill in the transparency as students fill in the CHART handout. Make this activity an interactive group project. Encourage discussion and questions.

   As you do this activity, introduce the following terms:

   column
   row
   cell
   label
   data
   value
   formula

2. In conclusion, ask students what they learned from this experience. Some possible responses might be:

   - Use a pencil, not a pen!
   - Double check everything before you begin calculating.
   - Really think through the design of your chart before you begin filling it in.

LESSON TWO: HOW TO USE A SPREADSHEET PROGRAM

OBJECTIVE: To demonstrate how people manage mathematical data using a computerized spreadsheet program.

EQUIPMENT: Computers (one for every two students), spreadsheet programs (one per computer), blank disks (one per student), computer with large screen monitor, and overhead.

PREPARATION: Each student will need a copy of the GRADES learning activity from the previous lesson. Have extra copies on hand for those who may have lost theirs. Make a transparency of figure 1, "So . . . A Spreadsheet." For each student, design and photocopy a reference command sheet that corresponds to the spreadsheet program your students will be using. If you using AppleWorks, photocopy the "Reference Command Sheet #1" on pages 13-15. The following points should be defined in your reference handout:

- How to boot up the spreadsheet program;
- How to create a spreadsheet file;
- How to name a spreadsheet file;
- How to move the cursor from cell to cell;
- How to record an entry;
- How to confirm an entry;
- How to edit an entry;
- How to enter a formula;
- How to read the screen prompts;
- How to access the help menu;
- How to initialize a disk; and
- How to save a file.

You may prefer to teach disk initialization and saving files as prerequisite skills.

ACTIVITIES:

1. Give each student a copy of REFERENCE SHEET #1. Read the reference sheet with students and demonstrate each command by creating a simple spreadsheet on the computer. This gives students the opportunity to read about the new information, to see it demonstrated and eventually to experiment with it in a hands-on environment. Encourage students to look at the program's documentation whenever possible. Knowing how to interpret documentation is a useful skill.
2. Re-assign the GRADES learning activity. This time students will use a computerized spreadsheet. Encourage students to work in groups of two.
3. When students have finished designing their spreadsheets, have them save them on disk under the file name GRADES.
4. Bring students together and lead a discussion of this experience.

- What did they learn?
- How was this experience different from their experience in lesson one?
- How would they explain the concept of spreadsheets to other people?
- What did they like about the program?
- What did they dislike about the program?
- How would they apply this program?

5. As a class, have the students name the steps needed to make effective use of a spreadsheet program. List their responses on the board or on a blank transparency. The list might look something like this:

   - Decide what you want your spreadsheet to do.
   - Make a very rough draft on paper.
   - Boot up the spreadsheet program.
   - Create a new data file.
   - Label the columns.
   - Label the rows.
   - Enter the data.
   - Enter the formulas.
   - Let the spreadsheet program do all the calculating.
   - Experiment with different values and let the spreadsheet program do all the recalculating.
   - Save your spreadsheet data file on disk.
   - Print out a hard copy of your spreadsheet.
   - Make a backup copy of your file on another disk.

6. In conclusion, discuss the transparency labeled SO. . . A SPREADSHEET. Ask students if they have anything to add to this list.

So . . . A Spreadsheet

1. Lets you define the problem.
2. Lets you decide on the steps you will use to solve the problem.
3. Helps you organize information.
4. Lets you draw conclusions about mathematical data.
5. Does all the calculations for you.
6. Lets you experiment with different values.
7. Lets you try out different alternatives.
8. Recalculates automatically.
9. Has a large storage capacity.
10. Is fast.
11. Is neat and tidy.

Figure 1.

A. Handout: Chart

A	B	C	D	E	F	G
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

B. Handout: Grades

1. Fill in the CHART handout using the information listed below.

COLUMNS
A1 NAME
C1 TEST
C2 ONE
D1 TEST
D2 TWO
E1 TEST
E2 THREE
F1 FINAL
G1 AVERAGE

ROWS
A3 ARTLEY
B3 MICHAEL
A4 BRENNEN
B4 MARY
A5 KOSY
B5 JONI
A6 LEONARD
B6 LORI
A7 SMITH
B7 BEN
A9 CLASS
B9 AVERAGE

2. Enter the following data into the correct cells.

NAME		TEST ONE	TEST TWO	TEST THREE	FINAL
ARTLEY	MICHAEL	95	100	97	100
BRENNEN	MARY	92	93	90	93
KOSY	JONI	82	85	87	92
LEONARD	LORI	75	82	89	90
SMITH	BEN	100	85	90	94

3. Figure out the student average for each student and enter the data in the column labeled AVERAGE.

   Write out the formula you used on this line:

   ____

4. Figure out the class average for each test and place this data in the row labeled CLASS AVERAGE.

   Write out the formula you used on this line:

   ____

5. Sorry, but you were given some incorrect information. You need to change a few things.

   BEN received a 78 on TEST THREE.
   LORI received a 100 on TEST ONE.
   JONI received a 68 on TEST TWO.

6. Please enter the new data and then recalculate where needed.

   ____

Spreadsheets in the Classroom: Part II
by
Joan Marie Brown

[Joan Marie Brown, University of Michigan — Dearborn, The Mall 1094, MI 48128.]

(Reprinted with permission from the *The Computing Teacher*, February, 1987.)

Last month we brought you two beginning activities for introducing the spreadsheet to your class: Before Spreadsheets, and How to Use a Spreadsheet Program . Once your students have mastered those two, they're ready for lessons three and four, on these pages.

LESSON THREE: HOW TO DESIGN A SPREADSHEET

OBJECTIVE: To give students the opportunity to design a spreadsheet.

EQUIPMENT: Computers (one for every two students), spreadsheet programs (one per computer), blank disks (one per student), and computer with large screen monitor.

PREPARATION: Photocopy the worksheet "Spreadsheet Story Problems" on page 10 for each student and design and photocopy a second reference command sheet for your spreadsheet program. (If you are using *AppleWorks*, photocopy the Reference Sheet #2 on pages 16-17.) The following points should be defined in your sheet:

- How to set standard values;
- How to change the layout of standard values;
- How to change column widths;
- How to delete;
- How to insert;
- How to move;
- How to copy;
- How to recalculate;
- How to find;
- How to arrange;
- How to fix titles; and
- How to window screens.

For demonstrating these commands, design a spreadsheet data file using the following information, or use one that a student designed last class period.

Template: Grades

NAME	TEST1	TEST2	TEST3	FINAL	AVERAGE
ARTLEY, MICHAEL	95	100	97	100	98
BRENNEN, MARY	92	93	90	93	92
KOSY, JONI	82	85	87	92	86
LEONARD, LORI	75	82	89	90	84
VERHEYDEN, BEN	100	85	90	94	92
CLASS AVERAGE	89	89	91	94	91

ACTIVITIES:

1. Hand out the reference sheet. Using the Grades data file, demonstrate each command and concept until your students understand it. Have them take notes and complete the reference command sheet as you explain and demonstrate. Whenever possible, encourage them to verbalize their understanding of this new information. This is a lot of material to cover. It may take more than one class period to cover it all.

2. Read through the Spreadsheet Story Problems worksheet. Tell students that, in groups of two, they will be responsible for solving one of the problems. As a class, discuss each problem. List questions that need to be answered for each before students can even begin working on them.

3. Obviously, before your students can tackle any of the Spreadsheet Story Problems, they are going to have to have some information made available to them. The best way to do this is to invite guest speakers into your classroom. For example, a car dealer and an insurance salesman would certainly be able to answer any questions students might have pertaining to Story Problem #1. A travel agent would be the person to contact for Story Problem #2. For Story Problem #3, I recommend inviting two different counselors from two different universities, or one from a local junior college and one from a university in another town. Expect students to take detailed notes. Based on their notes, they should then decide which problems they want to solve. At that point in time, have them consider the following questions:

    - How can they break this problem down into parts?
    - What kind of things might they consider in their solutions?
    - What kind of alternatives exist?
    - How should they structure their spreadsheets?

4. Assign the Spreadsheet Story Problems. Be available to answer questions.

HANDOUT: SPREADSHEET STORY PROBLEMS

Design a spreadsheet for one of the following story problems:

Story Problem #1
You are a junior in high school. It is almost June and you have just lined up a summer job. There is only one problem. You don't have a car, and you are going to need one to deliver pizzas. You have already talked this problem over with your parents and they are willing to cover half the cost of the car. But they are not willing to pay for the car insurance or any repair bills that you might incur. Design a spreadsheet to see exactly what you can and cannot afford.

Story Problem #2
Your class advisor wants to take your senior class on a trip over Christmas vacation. She has narrowed it down to three places: Toronto; Washington, DC; and Chicago. Design a spreadsheet in which you show the best value for your money. Consider all aspects of the trip.

Story Problem #3
You want to go to college next year, but you have no idea how much the year will cost you. Design a spreadsheet estimating your income and all expenses.

LESSON FOUR:
HOW TO EDIT AND PRINT A SPREADSHEET

OBJECTIVE: To give students the opportunity to edit and print out a spreadsheet.

EQUIPMENT: Computers (one for every two students), spreadsheet programs (one for every computer), data disks (one for every student), and a computer with a large screen monitor.

PREPARATION: For each student, photocopy the worksheet "Refreshments" on page 12 and design and photocopy a reference sheet on the printer options for your spreadsheet program. (If you are using *AppleWorks*, photocopy Reference Sheet #3 on page 18.) Enter and copy the following spreadsheet template on each student data disk.

```
1                 REFRESHMENTS                               PROFIT
2 A   B   C    D              E        F           G           H
3 __________________________________________________________________
4 WHEN DRINKS COST PER TOTAL PRICE PER TOTAL PROFIT
5 _________SOLD     DRINK  COST      DRINK SALES___________________
6
7   6/15     65      $.15              $.75
8   6/22     72       $.12               $.75
9   7/14    100       $.10               $.75
10  7/23     55       $.15               $.75
11  8/15    150       $.08             $1.00
12  8/30     35       $.15               $.50
```

ACTIVITIES:

1. Hand out the reference sheet #3. Using the Grades template, demonstrate each printer option until your students understand it. Have them take notes as you explain and demonstrate.

2. Assign the Refreshments learning activity. Have students work in groups of of two. Remind students to refer to their reference sheet #2 when needed. Have students save their work on disk.

3. Have students come together when they complete this exercise to discuss what they have learned.

4. Boot up the Grades template and show students how to print out a spreadsheet. Walk them through this procedure, then have them print out a hard copy of their Refreshments spreadsheet.

5. EXTENSION: This is an additional activity that you might want to assign to those groups that finish ahead of time. Have them design and research their own story problems, then solve them using a spreadsheet. Then have them present their projects to the class.

HANDOUT: REFRESHMENTS

1. Change the entry in cell A4 to DATE.

2. Create a new Column B.

3. Increase the width of Column B to 24 characters.

4. In cell B4 type in the label WHERE.

5. Enter the following labels in the correct cells.
   — B7 Diebolt's Bash
   — B8 Nowlin's Football Game
   — B9 Smith's Shower
   — B10 Brown's Party
   — B11 Jones' Open House
   — B12 Pizza Party/White's

6. Left justify all the labels.

7. Format Columns D, E, F, G, and H so that the data appears in dollars and cents.

8. Format Column C so that the data is a fixed integer number.

9. Delete Row 8 and replace it with the following information:
   — A8 6/22
   — B8 Jackson's Wedding
   — C8 70
   — D8 10
   — F8 50

10. Place the correct formulas in the cells labeled
    — TOTAL COST
    — TOTAL SALES
    — PROFIT
    and calculate.

11. Place row 7 after row 12.

12. Find all the places where drinks were sold for 75 cents.

13. Arrange Column B alphabetically.

14. Save this file on disk.

AppleWorks Reference Command Sheet #1

Note: The following information was adopted and adapted from the *AppleWorks Reference Manual*. If you are unclear about something, ask me or refer to the documentation.

Don't worry . . . we will experience, experiment, and explore each of these commands as an entire class before you go into your groups to do your work.

How to Initialize a Disk

This is a procedure that you only need to do once.

1. Insert your starter disk and press return.
2. Now insert your program disk and press return.
3. Choose OTHER ACTIVITIES from the MAIN MENU. Press return.
4. Choose FORMAT A BLANK DISK from OTHER ACTIVITIES. Press return.
5. Look at the prompt in the lower left hand corner of the screen. Type in the following disk name: MY.DISK. Press return.
6. Take the program disk out of the drive. Place the disk to be formatted into the drive. Press return.
7. Don't worry about the noise. This is a noisy procedure. You disk is initialized when the red light goes off on the disk drive. When that happens you should replace that disk with the program disk.

How to Make a Spreadsheet File

1. Insert your starter disk and press return.
2. Now insert your program disk and press return.
3. Choose ADD FILES TO THE DESKTOP from the MAIN MENU.
4. Choose MAKE A NEW FILE FOR THE SPREADSHEET from the ADD FILES MENU.
5. Type the file name of the new file.

Cursor Movement

Experiment with the following keys and record here what happens.

1. THE ARROW KEYS ______________________________

____

2. TAB ______________________________

____

3. OPEN APPLE-TAB ______________________________

____

4. OPEN APPLE PLUS THE ARROW KEYS ______________

____

5. OPEN APPLE 1 ______________________________

____

6. OPEN APPLE 5 ______________________________

____

7. OPEN APPLE 9 ______________________________

____

Some Basic Editing Commands

1. OPEN APPLE-E switches back and forth between overstrike and insert cursors.

   - The overstrike cursor lets you write over the information that's directly under the cursor; and
   - The insert cursor lets you insert information to the left of the character the cursor is on.

What does the overstrike cursor look like?

What does the insert cursor look like?

2. DELETE KEY deletes one character to the left of the cursor.

3. RETURN KEY confirms an entry.

4. THE ARROW KEYS confirm an entry and move the cursor over one cell in the direction of the arrow key being used.

5. OPEN APPLE-U lets you edit a cell that has a confirmed entry.

   Place the cursor in the cell you want to change, press OPEN APPLE-U, correct the information, and then press return.

Labels

1. LABELS are usually words.
2. Any entry that begins with a letter is considered a label.
3. Type a quotation mark (") before you type an entry that starts with a number when you want that number to be a label.

For example, if you typed "**1986** that entry would be accepted as a label.

Values

VALUES include numbers, pointers, functions, and formulas. We will be concerned mainly with numbers and formulas.

1. NUMBERS are entries that are used in calculations. They include the digits 0 through 9, and may include a plus sign (+), a minus (-), and/or a decimal point (.).
2. FORMULAS are mathematical statements. They calculate numbers. They must begin with a plus or minus sign, a decimal, the digits 0 through 9, a left parenthesis, or an @ sign.

For more information about the @ sign, refer to the Arithmetic Functions chart in the documentation. This chart includes definitions and examples.

What do you think this formula will do?

@SUM(7 + 3+ 7) ____________________________________

____

What about this one?

@SUM(A3 . . . A8) __________________________________

____

OPEN APPLE-Z will "zoom" you in so that you can see the formulas in the cells.

Help

OPEN APPLE PLUS THE ? will display the HELP Menu. When in doubt, press OPEN APPLE-?.

How to Save a File

Anytime you want, you can save the file you are working on by pressing OPEN APPLE-S.

AppleWorks Reference Sheet #2

Note: The following information was adopted and adapted from the *AppleWorks Reference Manual.* If you are unclear about something, ask me or refer to the documentation.

Don't worry . . . we will experience, experiment, and explore each of these commands as an entire class before you go into your groups to do your work.

Standard Values — Open Apple-V

THIS IS IMPORTANT!

Standard values have nothing to do with what is stored in the cell, but everything to do with how it is displayed.

Standard values affect the entire spreadsheet. Standard values tell, for example, whether labels are left justified, right justified or centered in cells. They also tell how many decimal places values should have, or whether they should have dollar or percent signs.

Open Apple-V is the first command you should use when you begin setting up a spreadsheet.

We will experiment with each part of this command as a class before you work in groups at the computers.

Layout Values — Open Apple-L

THIS IS IMPORTANT!

Open Apple-L lets you override the standard values for *specific cells* in the spreadsheet.

Suppose you want dollars instead of percents in column B. This command will let you do that.

We will experiment with each part of this command before you work in groups at the computers.

Some Additional Editing Commands

Let's experiment with the following commands to find out what they do.

1. OPEN APPLE-D lets you ____________________
2. OPEN APPLE-I lets you ____________________
3. OPEN APPLE-M allows you ____________________
4. OPEN APPLE-C lets you ____________________
5. OPEN APPLE-K lets you ____________________
6. OPEN APPLE-A lets you ____________________

7. OPEN APPLE-F helps you ________________

8. OPEN APPLE-N lets you ________________

How to Fix Titles

Open Apple-T lets you fix the titles into place either at the TOP or at the LEFT of your spreadsheet, or BOTH.

To fix titles at the top of your spreadsheet you must . . .

To remove fixed titles you must . . .

How to Window Your Spreadsheet

Open Apple-W lets you split your spreadsheet into two windows, either side by side or top and bottom.

To split your spreadsheet side by side you must . . .

To split your spreadsheet into top and bottom you must . . .

Open Apple-J moves the cursor to the corresponding cell in the other window. It lets the cursor jump from one window to the other.

To SYNCHRONIZE the two windows, just press Open Apple-W and choose synchronize. You can now move both windows of your spreadsheet at the same time so that row for row or column for column, the two windows will match.

To restore your spreadsheet back to one window, press Open Apple-W again and choose ONE.

AppleWorks Reference Sheet #3

Note: The following information was adopted and adapted from the *AppleWorks Reference Manual.*

How to Print Out

Open Apple-O lets you work with the PRINTER OPTION MENU.

Platen width
Left margin
Right margin
Characters per inch
Paper length
Top margin
Bottom margin
Lines per inch
SC (SPECIAL CODES)
PH (PRINT REPORT HEADER)
Spacing

Open Apple-P lets you print out a hard copy of your spreadsheet.

Choose All, Rows, Columns, or Block

4.5

Session 5: Using a Spreadsheet to Generate "What If?" Questions

4.5.1 Narrative Overview

To a very large extent, scientists increase their knowledge and understanding of science through the careful formulation of questions and the development of means to help answer the questions. The means for answering questions may be laboratory equipment, careful observation, the development of mathematical models, and so on. Once a scientist has developed appropriate methodology to answer questions, the scientist will likely ask a series of "What if?" questions. What if I increase the gas pressure? What if I decrease the mass? What if I increase the velocity? What if I double the amount of reagent? What if the time goes to nearly zero?

The goals of Session 5 are:

1. To provide another example of how spreadsheets can be used to facilitate the generating and testing of hypotheses in the science classroom. We will do this by asking and answering "What if?" questions, making use of a spreadsheet model to help answer the questions.

2. To provide participants with practice implementing an electronic spreadsheet model to help solve a specified problem.

Integrating use of a spreadsheet into regular instruction is conceptually more difficult than learning to make use of software applications such as databases, graphing, and word processing. Our NSF project research indicates that numerous examples and substantial practice time are necessary. A two hour session is insufficient to accomplish these goals. If time permits, we recommend that the time devoted to the content and ideas of Session 5 be expanded by 4-6 hours.

If the two hour session given here is to be expanded to eight hours, we suggest:

1. Use Activity 1 and Activity 2 during the first two hours.

2. Allocate an entire two-hour session to Activity 3.

3. Devote the third two-hour session to the development of a spreadsheet and materials for use in the participants' classrooms.

4. Design a fourth session consisting of peer teaching the newly developed lessons and the sharing of experiences of participants piloting the lessons in their classrooms.

Activity 1 is an off-computer activity where participants generate "What if?" questions and set up a paper spreadsheet. They then use the paper spreadsheet and by-hand calculations to answer the questions. The debriefing should focus on pointing out the similarities between the paper spreadsheet and an electronic spreadsheet. You also want to introduce terms such as cell, label, numeric values, and formulas in the context of designing and using a spreadsheet.

Perhaps the most important idea of spreadsheets is that they are an aid to developing certain types of mathematical models and then carrying out the computations in the models. A great deal of the "thinking" part of using a spreadsheet occurs as one develops the model for a particular problem. This thinking must be done whether the spreadsheet is to be implemented on paper or on a computer. As participants work on designing their paper spreadsheet, get them actively engaged in talking about the type of thinking (higher-order skills, problem solving) that is necessary to develop a model to help solve a science problem.

Activity 2, Using a Spreadsheet to Answer "What if?" Questions, demonstrates the advantages of an electronic spreadsheet over a paper and pencil approach. Once a spreadsheet model has been developed, much of the work of answering the "What if?" questions is done by the computer. In addition, it is often much easier to change a spreadsheet model than to change a pencil and paper model. This makes it possible to explore a wider range of questions. During this activity, allow participants time to play, to experiment, to do trial and error exploration. Our piloting of these materials indicated this was one of the best methods for generating excitement about this use of spreadsheets.

During the debriefing, brainstorm with participants to determine science content or concepts that might be taught using spreadsheets. Continue with this activity until you have a minimum of four or five applications in each science area (biology, chemistry, earth science, physics or physical science). This activity helps teachers identify places in their curriculum where they may wish to develop a spreadsheet activity. Finish the debriefing with a discussion of the how using spreadsheets as instructional tools aids both high and low level students. Review the timeline for specific suggestions on this point.

Activity 3, Creating a Spreadsheet to Answer "What if?" Questions, focuses on the details of actually setting up a spreadsheet model on a computer. Please note that one activity is barely sufficient for participants to feel comfortable trying this process on their own. Many colleges give entire courses on how to use a spreadsheet.

During the NSF project we introduced spreadsheets as an aid to students developing and using models to solve science problems. Certainly that is the ultimate goal for the use of spreadsheets in science. However, there is an alternative approach that can be used to introduce teachers to spreadsheets. The teachers can be taught how to use a spreadsheet for their own personal needs, or for educationally related needs. In the former category, teachers might learn to use a spreadsheet to keep a household budget. In the latter category, teachers can be taught to use a spreadsheet to record student grades. The rational behind this approach is that as teachers become more comfortable using spreadsheets, and understand their capabilities, they will see ways to use them in regular instruction. The evidence to support this rationale is sparse. The research strongly suggests that if you want teachers to exhibit a certain classroom behavior, you should give them specific instruction and practice in that behavior.

The increasing availabilty of spreadsheet software and other computer aids to mathematical modeling is a challenge to our science education system. Many science teachers note that their students have relatively poor computational skills, and perhaps have students make use of calculators to circumvent this difficulty. But a great deal of science depends on mathematical modeling. It requires a reasonably good understanding of mathematics (for example, of algebra and geometry) to develop mathematical models of some of the simpler situations that occur in science. The more complex situations are modeled using calculus and higher levels of mathematics. We can provide students with access to computer aids to mathematical modeling. But this does not circumvent the problem that students need to have a reasonable understanding of the mathematics being used in the modeling process if they are to be successful in developing and making appropriate use of mathematical models.

4.5.2 Script

Theme	Using spreadsheets to develop mathematical models as an aid to solving science problems; using spreadsheets to actually help solve science problems.

Objectives

1. To provide an example of how spreadsheets can be used to facilitate the generating and testing of hypotheses in the science classroom. Participants will practice asking and answering "What if?" questions. A different way to view this objective is that the intent is to study the use of spreadsheets to develop mathematical models useful in the sciences.
2. To provide participants with practice in implementing an electronic spreadsheet to help solve a specified problem. (This is an objective suitable for participants who have used a spreadsheet before.)

Materials:

Software	***Hardware***
Microsoft *Works* Program disk	Macintosh computers
Microsoft *Works* Data disk	with printers

Handouts
Activity 1: Generating "What if?" Questions
Activity 2: Using a Spreadsheet to Answer "What if?" Questions
Activity 3: Creating a Spreadsheet to Answer "What if?" Questions
Game of the Week

Resources

overhead projector
overhead markers
handheld calculators (optional)
refreshments

Setup

Macintosh computers and Microsoft Works software should be set up before participants arrive. An appropriate number of the handouts should be placed at each computer work station, along with the needed data disk. (Provide participants with calculators if you feel it will help them on the first activity.)

Introduction

Although the Narrative Overview discusses three activities, most participants will find that there is not time to do all three during the session. Participants with little or no previous experience with spreadsheets will do the first two activities. Participants with a solid background in using spreadsheets will browse the material of Activity 1, move immediately into Activity 2, and then continue with Activity 3.

It is important that the facilitator help participants understand that a spreadsheet is a piece of computer software specifically designed to help develop and implement certain types of mathematical models. A spreadsheet is a rather limited aid to mathematical modeling, and was not specifically designed for use in the sciences. Rather, it was designed originally for developing financial models in business. However, it is a powerful aid to building rather general mathematical models. Thus, a spreadsheet is quite useful in addressing a number of the types of problems that come up in the study of science.

Activity 1

As participants arrive, get them into pairs or groups of three, and have them

30 minutes

begin to work on Activity 1. (By now you should know which of your participants have already used spreadsheet software. If you intend to have these participants move rapidly on to Activity 2, you will want to group them accordingly. If you want to keep all participants working together, make sure that there is one participant who has spreadsheet experience placed in each group.) There are several underlying goals in Activity 1. Participants become familiar with the specific problem being addressed. They practice solving it by hand. They practice developing "What if?" questions and answering them. They begin to detect a pattern in the types of computations needed to answer questions related to Activity 1.

Debrief
20 minutes

Focus on the patterns that seem to be emerging. What role do humans play in posing and answering the questions, and what role might a computer play? Are there lots of areas in the sciences which seem to lead to questions as occur in Activity 1? Which aspects of generating and answering the questions seem suited to particular levels of students or to specific science classes?

Break
10 minutes

Relax, socialize, and enjoy.

Activity 2
30 minutes

Participant move to the Macintosh computers, load the Microsoft Works software, and begin to experiment with the computer spreadsheet representation that corresponds to Activity 1. Initially, the emphasis is on becoming familiar with use of the spreadsheet software. However, this is relatively easy, so that the emphasis soon switches to solving problems.

Debrief
20 minutes

Focus the discussion on what parts of Activity 1 can readily be turned over to a computer, and what role humans play in solving these types of problems. How much training and experience might it take for a secondary school science student to learn to make use of a spreadsheet model that has been developed by someone else? Is this a useful thing to do in science education? What is gained, and what is lost?

It is important to realize that some of your inservice participants may not have a good understanding of model building, hypothesis generating, and hypothesis testing. As you help such teachers learn about spreadsheets, your underlying goal is to change the way that they approach the teaching of science. This is a major task. You should expect resistance, and you should be very pleased if you achieve even modest success

Closure
10 minutes

Allow some time to coordinate the Game of the Week, which is a continuing, multi-week activity. Also allow time for questions about the term projects. Keep the computer lab open for an hour, so that participants can work on activities of their choice or on Activity 3.

4.5.3 Timeline

Before participants arrive have the Microsoft *Works* Program disk and the data disk at each computer. Machines will be turned off. Group participants into pairs or triads as they arrive. Group participants with previous spreadsheet experience together if you want these pairs to move rapidly to creating their own spreadsheets.

0:00 - 0:30 30 min	Participants will complete Activity 1. Activity 1 models the first phase of using spreadsheets to generate and test hypotheses. In this phase, participants solve some problems by hand and eventually detect a pattern of repeated and/or quite similar calculations. Computers tend to be quite useful in situations where a fixed set of calculations need to be done repeatedly.
0:30 - 0:50 20 min	Debrief Activity 1. Did any participants make use of handheld calculators? What did participants learn by doing Activity 1? Is it a suitable activity to use with science students? Focus on developing a model, a pattern, and other places in science education where somewhat similar models or patterns appear.
0:50 - 1:00 10 min	Break
1:00 - 1:30 30 min	Participants will complete Activity 2. The activity demonstrates use of a spreadsheet to carry out the calculations needed to solve a collection of nearly similar problems.
1:30 - 1:50 20 min	Debrief Activity 2. How long did it take to learn how to use the spreadsheet? How long would it take science students to learn to use this spreadsheet? Was the software easy to learn how to use, and was it easy to use? What would make it better? How would science education be affected by making such software available to students? Would science education be better or worse?
1:50 - 2:00 10 min	Closure. Make sure that the multi-week game on moods and weather is progressing smoothly. Note that this week's Game handout contains a new Game that is to be done during the coming week. Allow time for questions about the term projects.

4.5.4 Handouts

These handouts are needed during Session 5. The facilitator may want to make some of these into overhead projector foils for use during the inservice.

Index to Handouts **Page**

Activity 1: Generating "What if?" Questions 2

Activity 2: Using a Spreadsheet to Answer "What if?" Questions 5

Activity 3: Creating a Spreadsheet to Answer "What if?" Questions 8

Game of the Week 13

Activity 1
Generating "What if?" Questions

Problem

It is nearing lunch time and you know that you are wrestling late this afternoon in the 150 pound weight class. Currently you weigh 149 pounds. For lunch you would like to eat two Big Mac's. The question is: Do you have enough time to use up the Big Mac calories so your weight does not go over 150 pounds? You intend to do some exercising during the afternoon, so you know that you will burn up some calories.

You also have in mind other types of "junk food" that you might decide to eat. Thus, you need to develop a procedure for solving the weight problem for a variety of different choices of menu.

This handout contains a calorie chart for selected food items. It also contains a chart that can be used to determine how many calories are burned up by a variety of physical activities. These charts and a spreadsheet (either on paper, or in a computer) can be used to develop a procedure for solving a wide range of weight problems.

Solution

1. Calculating the caloric intake of a proposed lunch.

Step 1: Determine a food item that you would like to eat and the number of servings.
Step 2: Use the Junk Food Calorie chart to determine the number of calories per serving.
Step 3: Multiply the number of servings times calories per serving. This equals the total calorie intake (**TCI**).
Step 4: Repeat Steps 1-3 for other items on your menu, and accumulate the total calories for the proposed lunch.

2. Determining the amount and type of exercise needed to burn the calories of the proposed lunch.

Use the Victor Katch formula (details are given below; a Calorie Conversion Factors table is given later in this document) to help you determine the best activity to burn up the calories from your proposed lunch.

Step 1: Write down your body weight.
Step 2: Select an activity from those listed in the Calorie Conversions Factors table.
Step 3: Multiply your body weight by calorie conversion factor (refer to Calorie Conversion Factor table). This equals the calories burned per minute (CBM) by the activity.
Step 4: Multiply **CBM** by the length of the workout. This equals the total calories burned (**TCB**).
Step 5: Subtract **TCB** from total calories intake (TCI). If the result (the energy balance) is close to zero, essentially all calories are used up and there will be no weight gain or loss.

Note that this is a very simple-minded and inadequate model of weight gain and weight loss. It does not take into consideration non-caloric fluids. A key idea in developing models is to include all of the relevant factors. The modeling of even rather simple-looking situations can be quite difficult.

Complete the chart given below. It provides a guide to solving the proposed lunch problem if lunch is to consist of one or more servings of a single food item. You can easily modify it to fit the situation of a proposed lunch consisting of several different food items.

Type of Food: ________________

Number of Servings: ________________

Calories per serving: ________________

Total Calories: ________________

==

Your weight (lbs): ________________

Activity: ________________

Calorie conversion factor (from table): ________________

Calories burned per minute: ________________

Length of workout: ________________

Total calories burned: ________________

==

Calorie Intake: ________________

Calories Burned: (Minus) ________________

Energy Balance: (Equals) ________________

After you have solved one energy balance problem, make up several additional problems by asking "What if?" questions. For example, in the original problem, what if the person weighed 160 pounds? Use the space below and additional sheets to ask several questions, and answer them as time permits.

Junk Food Calorie Chart

Junk Food	Serving Size	Calories
Chocolate	1.2 oz	224.4
Fudge	1.0 oz	113
Michelob	1 bottle	165
Big Mac	1	563
Whopper with cheese	1	740
Chocolate Ice Cream	1 scoop	165
Vanilla Ice Cream	1 scoop	147

Note: The serving size is not used in the activity. It is provided as background information.

Reference Kraus, B. (1983). *Calories and Carbohydrates.* New York: New American Library.

Calorie Conversion Factors

Activity	Calorie Conversion Factor
Aerobic dancing	.076
Circuit weight training	.085
Cycling (leisure)	.054
Gardening	.044
Golfing	.038
Jogging	.062
Rowing (machine)	.046
Skiing (cross-country)	.065
Swimming (leisure)	.058
Tennis	.050
Walking (leisure)	.037
Walking (up hills)	.055

Activity 2
Using a Spreadsheet to Answer "What if?" Questions

Activity 2 uses the **Energy Balance** spreadsheet (on your Microsoft *Works* data disk) to help you solve the types of problems discussed in Activity 1. All you have to do is to enter data into the correct cells in the spreadsheet in a systematic trial and error fashion. The spreadsheet program will do the computations for you, but you will need to do the thinking to make the trial and error procedure work.

A good way to begin is to browse the spreadsheet. Doing so will help you understand the functioning of the spreadsheet and how it was created. Here are some questions that you can answer to help you understand this spreadsheet. After you answer them, make up and answer some additional questions about the design of the spreadsheet.

- Notice that one part of the spreadsheet contains the **Junk Food** menu. What cells contain the names of the items on this menu?
- What cells contain the number of **Calories per Serving** for the food items on the menu?
- Why do you suppose that the **Servings** cells all contain the number 0?
- Highlight one of the **Calories Consumed** cells that corresponds to a food item. What is the formula that the spreadsheet is using to compute the value in this cell?
- Notice that one part of the spreadsheet contains the list of **Activities** that can be used to burn calories. Which cells are these?
- What cells contain the **Calorie Conversion Factors** that correspond to the various activities that burn calories?
- Why do you suppose that the **Hours** cells that correspond to the activities all contain the number 0?
- Highlight one of the **Calories Burned** cells that corresponds to a particular activity. What is the formula that the spreadsheet is using to compute the value in this cell?
- In using the spreadsheet to solve a problem, into which cell will you enter the person's weight?
- Make up one or two additional questions about the design of the spreadsheet. Give the questions and the answers in the space below.

Now you are ready to use the spreadsheet to solve some energy balance problems. The spreadsheet is designed to do the calculations as you ask "What if?" questions. It is not designed to actually solve an energy balance problem. For example, suppose you want to know how many hours of aerobic dance a 140 pound person would need to perform in order to consume the calories in a Whopper with cheese and two scoops of vanilla ice cream. You might proceed as follows:

1. Enter the number 140 into cell B28. This represents the person's weight.

2. Enter the number 1 in cell B6 (this represents 1 Whopper with cheese) and the number 2 into cell B8 (this represents 2 scoops of vanilla ice cream).

Notice that the contents of cells D6, D8, and D10 change as you enter this data. Cell D6 now contains the calories in 1 Whopper with cheese; cell D8 now contains the calories in 2 scoops of vanilla ice cream; cell D10 contains the sum of the calories in the 1 Whopper with cheese and the 2 scoops of vanilla ice cream.

3. Now make a first guess as to the number of hours of aerobic dance that would be needed to burn this many calories. As a first guess, try 1.5 hours. Enter the number 1.5 in cell C14.

Notice that the calories burned by this amount of aerobic dance are displayed in cell D14; the total calories burned (which is the same number, since only one exercise is being done) appears in cell D27; the Energy Balance is displayed in cell B30.

4. If the Energy Balance is a positive number, enter a number larger than 1.5 hours into cell C14. If the Energy Balance is a negative number, enter a number smaller than 1.5 hours into cell C14. Continue to make trials until you achieve an Energy Balance that is fairly close to 0. Enter your guesses and the resulting Energy Balance in the space below.

5. Next, change the person's weight to 190 pounds by changing the contents of cell B27 to 190. Describe the resulting Energy Balance. (Remember, the amount of food and the hours of aerobic dance have not been changed.)

6. Make several additional changes to the person's weight, and observe the resulting Energy Balance. Enter the results in the space below. Write a conjecture about how the Energy Balance relates to the person's weight for the particular menu of foods consumed and hours of aerobic dance performed.

Now you are ready to formulate your own problems and use the spreadsheet to solve them. One key point to remember is that the spreadsheet "remembers" data that you have entered (until you **Close** it or **Quit**, at which time you can either save the most recent version you created, or delete it). Thus, as you start a new problem, you will either want to enter zeros to replace the data you entered for the previous problem, or you will want to reload the spreadsheet from the original that is stored on disk.

Problem ____

____

____

____

Use the space below as a worksheet in solving the problem that you have stated.

Activity 3

Creating a Spreadsheet to Answer "What if?" Questions

This handout leads you through the steps needed to create the Energy Balance spreadsheet used in Activity 2. As you can see, there are a large number of steps involved. Creating a spreadsheet has many of the characteristics of writing a computer program. Many of the same types of difficulties, such as syntax errors and errors in the logical design, can occur. Thus, it is common to produce a spreadsheet that contains errors and must be debugged.

The processes of testing and debugging a spreadsheet are similar to those used in testing and debugging a computer program. Indeed, there is a reasonable amount of transfer of learning from one task to the other. In the set of directions given below, occasionally you are directed to test out small parts of the spreadsheet that you are entering.

1. Inserting your disks.

- Insert the **Microsoft *Works*** Program disk in the internal drive.
- Insert the **Microsoft *Works*** Data disk in the external drive.

2. Selecting the external drive and creating a new file.

- Click **Drive**.
- Open the "**Microsoft Wo...**" desk by clicking twice on the icon.
- Create a new file by clicking on the **spreadsheet icon** at the top of the screen.
- Click in the **New** box.

3. Entering data.

- Select cell **A1** (point to cell A1 and click the mouse).
- Type the label **Junk Food.**
- Select **Bold** from Format Menu.
- Press **Return.** Pressing **Return** stores the data, in this example a label, and moves the selection one cell down.
- Type in the **Junk Food** names from the Junk Food Calorie Chart: Chocolate, Fudge, Michelob, Big Mac, etc. pressing **Return** after each. What you are accomplishing here is placing the menu into cells A2, A3, ... A8.

To widen **Column A**

- Move the cursor over the dividing line between **Column A and Column B**. The cursor becomes a double arrow pointing left and right.
- Hold the mouse button down, and drag the pointer to the right. When the dividing line is where you want it (column A is large enough), release the mouse button.

4. To enter the next column label:

- Select cell **B1**.
- Type the label **Servings.**
- Select Bold from the **Format Menu**.
- Press **Return.**

5. To enter the numeric values of servings without units:

- Type in the number **0**.
- Press **Return.**

The number **0** should appear in cell **B2**. To copy **0** (number of servings) into cells **B3 - B8**:

- Select cell **B2** and hold the mouse button down.
- Drag the mouse down to cell **B8**. Cells **B2 - B8** should now be highlighted. Release the mouse button.
- Select **Fill Down** from the **Edit** menu. The number **0** should appear in cells **B2 - B8.**
- Select **Align Center** from the **Format Menu.** The values should be centered in cells **B2 -B8.**

6. To enter the next column label:

- Select cell **C1**.
- Type in the label **Calories**.
- Select **Bold** from **Format Menu**.
- Press **Return**.

7. Enter the numeric values of calories without units.

- Type in **224.4** from Junk Food Calories Chart.
- Press **Return**.

Continue by typing in the caloric values for the rest of the Junk Foods listed. You want these caloric values to be in cells C2 through C8, corresponding to the food items in cells A2 through A8.

8. Enter the next column label, Calories Consumed.

- Select cell **D1**.
- Type in the label **Calories Consumed**.

- Select **Bold** from the **Format Menu**.
- Widen the column.
- Press **Return**.

You will instruct the spreadsheet to calculate the values in column **D (Calories Consumed)**. The calculation is based on the number of servings, in **Column B,** and the calories, **Column** C. The formula can be expressed as:

Calories = Servings X Calories/Serving

To enter the formula:

- Select cell **D2.**
- Type an **equal sign** (=), followed by the formula:

  B2 * C2

  Note: The * means to multiply.
- Click on the **enter box**, the box with the check mark, next to the entry bar.

To view the formula and place copies into cells **D3 - D8**:

- Select **Show Formulas** from the **Options Menu**.
- Select cell **D2** and hold mouse button down.
- Drag the mouse down to cell **D8**. Cells **D2 - D8** should be highlighted. Release the mouse button.
- Select **Fill Down** from the **Edit** menu.

Examine the formulas. Notice that the formulas are different in each cell.

Each formula refers to two cells. The **cell reference** in **D2** is **B2** and **C2.** In this case the cell references are **relative**. The spreadsheet uses the current value of the appropriate cells and calculates the results. Change the value of the **cell reference** and the spreadsheet will automatically recalculate the results in column D.

To view the formula in action:

- Select **Show Values** from **Options** menu.
- Select **B3** and enter **3**.
- Watch **D3** as you click on the **enter** box.
- Select **B3** and enter 2.
- Click on the enter box and observe D3.

- Select **B3** and enter **0**.
- Click on the **enter** box.
- **Describe** your observations in the space below.

9. To complete the total calories part of the spreadsheet:

- Select cell **C10**, type in the label **Total Calories**, **bold** it, and press the Tab key. Cell **D10** should be highlighted. (Use of the Tab key moves the cell selection to the right one cell at a time, while the Return key moves the cell selection down one cell at a time.)
- Type in the formula, **=Sum(D2:D8)** and press **Return.** The formula is spreadsheet notation for computing the sum of the contents of the cells D2, D3, D4,..., D8.
- Enter some values for servings (column B) and watch the **Total calories** change.
- Return the servings to **0** for each type of **Junk Food**.

10.To add the calorie burning chart and computational procedures to the spreadsheet:

- Select cell **A13**.
- Type the label **Activity**.
- Bold the **label**. Select **Bold** from the **Format Menu.**
- Press **Return**.

Type in the remaining **Activity** names from the **Caloric Conversion Factor** chart.

Circuit weight training...Walking (up hills)

pressing **Return** after each entry. Widen the column if the labels do not fit.

- Select cell **B13** and enter the label **Calorie Conversion Factor.**
- Enter the conversion factors for the different activities from the Calorie Conversion Factors chart.
- Select cell **C13**, enter the label **Hrs Exercised**.
- Enter a **0** value for all cells in this column as you did in the previous activity for servings.
- Select cell **A28** and enter the label **Body Weight**, bold, and press Tab.
- Cell **B28** should be highlighted. Enter your current weight, or any number you would like to represent your weight.
- Select cell **D13** and enter the label **Calories Burned**. Calories Burned is calculated by the spreadsheet.

The calculation is based on the hours of exercise, caloric conversion factor, and a time conversion. The formula can be expressed as:

Cal. Burned =(Cal Conversion Factor)(Hrs Exercised)(60)(Body Wgt)

To enter the formula:

- Select cell **D14**
- Type an **equal sign** (=), followed by the formula:

  B14*60*C14*$B$28

  Note: The * means to multiply.
- Click on the **enter** box.

The previous formula uses an **Absolute Cell** reference. An absolute cell reference causes the spreadsheet to use the specific value in cell **B28** for every row. If you copy this formula to a new location it will adjust the **relative reference** to reflect the new row, but the **absolute reference** will remain the same.

- Use **Fill Down..** to copy the formula into cells **D14 - D25**.

  Look at the formulas. Note **B14** and **C14** change with each row but **$B$28** stays the same.
- Select cell **C27** and enter label **Total Calories Burned**, bold, and press Return.
- Select cell **D27**, enter the formula, **=Sum(D14:D25),** and click on the **enter** box.
- Select cell **A30** and enter the label, **Energy Balance**, bold, and press Tab. Calculation of the Energy Balance requires subtracting the total of Junk Food Calories from the total calories used during physical activity:

Formula:

Energy Balance = Total Calories - Total Calories Burned

Translate the preceding formula into the form required by the spreadsheet.

- Select the cell location (B30) of the formula.
- Formulas must start with an equal sign (=)
- Type in the the cell location, where the formula **Total Calories** is located. Subtract from this the **Total Calories Burned**.
- To enter the formula click on the enter box.
- Select **Save** from the **Edit** menu. Release the mouse button. You will be given an opportunity to type in a file name for the spreadsheet you have created. Do so, and save your file to your data disk.

11. You have now completed the spreadsheet used in Activity 2. Test it out with some of the problems you solved in Activity 2.

Game of the Week

Part 1

Beginning in Session 3 and continuing through Sessions 4 and 5, the Game of the Week relates to designing an experiment to determine if there is a relationship between the weather and a person's mood. This requires the development of measurable definitions of both "weather" and "mood." The goal is to develop definitions that students can follow with reasonable consistency. Once the definitions and appropriate data collection forms have been developed, you will use them with some of your students for several weeks. You will be expected to turn in summary statistics and a brief written report on this project at the last inservice session.

Your assignment this week is to do a final redesign of your definitions and your one page form (8 1/2 by 11) to record daily observations of a person's mood and the weather. Take into consideration the materials developed by other inservice participants, but stick to your guns. If you feel your ideas are good, don't throw them away.

Begin by carefully writing down one or more conjectures (hypotheses, predictions). Then collect data using your definitions and data collection forms. Do this for a "reasonable" number of students, such as a whole class. The assignment is to collect a substantial amount of data during the next three weeks and to prepare a final report to turn in at the last inservice session. Your final report will include summary statistics and a brief written report. Did the data support your hypotheses? What relationships, if any, do your data suggest? Most likely you will want to make appropriate use of a database or spreadsheet in doing this work.

Part 2

Scientists frequently make use of the types of computations that can be done on a spreadsheet. Scan through several textbooks used in science courses that you teach. Find at least a half dozen examples of charts or tables that would fit a spreadsheet format. The distinguishing characteristics to look for are tables in which one or more of the columns (or rows) are computed using simple formulas applied to data in other columns (or rows). Turn in a brief description of each of the examples. Your description should include a clear specification of the problem being addressed and the level of mathematical knowledge needed to deal with the mathematical models in the example.

4.6
Session 6: Doing a Science Lab Using Integrated Software

4.6.1 Narrative Overview

An integrated software package such as Microsoft *Works* contains a number of software applications. The actual applications and the ways they interact with each other vary with the design of the integrated package. Also, a particular integrated software package will be modified over time, as the designer seeks to improve the program and to more effectively compete with other integrated packages.

For example, the word processor in an integrated software package must in some sense compete with stand alone word processors. But stand alone word processors are getting better and better. They are gradually incorporating many of the features that were initially available only in desktop publication software. Thus, one can expect that the word processor in an integrated software package will undergo major changes over a period of years.

An integrated package is designed to be relatively easy to learn how to use and relatively easy to use. However, as more and more features are added, the package tends to become more and more complex. The typical integrated package is accompanied by a quite thick instruction manual. It can easily take a three- or four-credit college course to cover the major features of an integrated package.

An alternative is to initially learn to do just a few simple things using the integrated package, and then begin to use these features. As one encounters problems that require use of more advanced features, study the manual and/or get some help in learning them. This "learn by doing" approach works well for most people, since they are highly motivated to learn features that they need to use.

We know, of course, that learning by doing, and having the opportunity to make immediate use of what one is learning, is a good model for much of education. Unfortunately, schools often find themselves in the situation of needing to teach students something that they will not be using for many years. Teachers have learned to adjust to this situation. Indeed, some have become so acclimated to this situation that they have trouble adjusting to a teaching environment in which immediate application can occur.

Computer application software can be used to create environments in which students can make immediate use of the computer applications they are learning. They do not need to master all features of the software before beginning to apply the software. A case in point is use of an integrated software package in a science lab. A key part of doing a science lab is doing the lab report. A lab report often contains a combination of written remarks (think about using a word processor), data (think about using a database), computations (think about using a spreadsheet), and graphics (think about using graphics software). The student who has knowledge of even one of these types of software can use it in doing parts of a lab report. As the student learns more features of a particular software application and more software applications, the student can gradually do more and more of the lab report on a computer.

Initially, of course, it will be easier for a student to do a science lab report by hand than to make use of a computer. But gradually, skill in using the computer will increase so this is no longer the case. Also, most students will take great pride in the quality of the final product that they produce using a computer.

Session 6 of the NSF inservice focuses on use of an integrated software package to do a science lab report. This session can be viewed at two levels. At one level, the ideas from this session can be used by the course instructor to prepare the lab assignment, the handouts that are given to students. At a second level, the ideas can be taught to students so that students can use them in doing their science lab reports.

As suggested above, a science lab assignment or report generally consists of a combination of:

1. Written material.
2. Data, some known in advance, some collected during the experiment.
3. Computations based on the data and on underlying theory.
4. Graphics, which may include both diagrams and mathematical graphs.

One approach to doing a lab report is to have a lab manual with detailed printed instructions and spaces for writing in results. While this can be quite satisfactory for simple labs, it does not fit well with more complex labs. Nor does it fit students' varying handwriting characteristics (some can write quite small, others require more space) or thinking skills (some think only short thoughts, others think very long thoughts). Moreover, the preprinted lab manual approach to writing up science labs suggests that any lab experiment is rather cut and dried, that all students will do exactly the same thing, and that all students will achieve the same results.

The use of an integrated software package in doing lab reports can help change this. The cut and paste features of such software allow substantial flexibility in writing up a report. Moreover, as the student progresses in writing a lab report, it is easy for the student to go back and add additional descriptions, graphs, and so forth.

Indeed, in certain circumstances it is desirable that a lab be repeated, or that a student go back and gather more data. In other circumstances it is desirable to combine data and ideas from several labs. An integrated computer software package can be of considerable help in doing the lab report in these cases.

A compromise between having a preprinted lab manual and having a completely free form approach is to provide students with a computer template for their lab reports. The template is, in essence, a lab report manual on a computer. The student follows the template, but has the flexibility of using the amount of space that is actually needed as well as the flexibility of adding more material and making changes to previously written materials as the writing proceeds.

The template idea is also quite useful to teachers who are preparing their lab assignments on a computer. The idea is to develop a general format that fits the nature of the course, the assignments, the students, the instructor, etc. This template then serves as the starting point for creating each lab assignment.

The Microsoft *Works* integrated software package was designed for use in a business environment, rather than in science education. Thus, the package lacks a number of features that are useful in science and in science education. For example, the graphics facilities are quite limited, and there are no equation solving facilities. The package does not provide features for the online gathering of data from science experiments, nor the controlling of such experiments.

There are a number of software applications that have been designed to meet specific needs of scientists and science educators. The idea of "probeware" is now common in science education. A probeware package contains hardware and software designed for the online gathering of data, and may also be able to control certain aspects of an experiment, for example by turning a heater on and off.

The study of probeware is a common component of computer-integrated instruction inservices designed for science teachers. In the two pilot trials of the materials in this book, we included probeware one time, and excluded it the other time. There is no doubt that probeware is a useful and exciting topic for science education. Our main reasons for excluding it were that there are many printed materials that describe its use (lots of inservices have been done in this area) and that we lacked time to adequately cover the other topics we had chosen to include.

If you decide that probeware is to be emphasized in your inservice, you will likely want to obtain probeware that interfaces well with the computer that is being used for the rest of the inservice sessions. It would be appropriate to devote part of Session 6 and/or much of Session 7 to use of probeware. This ties in well with using the computer system to analyze the experimental data obtained through use of the probeware, and then integrating the results into the lab report. If you decide to exclude specific instruction in the use of probeware, then it would be appropriate to devote part of Session 6 to a discussion of probeware and some of its potential impact on science education.

4.6.2 Script

Theme

Using an integrated software package to do a science lab report.

Objectives

1. To introduce participants to the use of an integrated software package for use in doing a science laboratory report. The emphasis is on secondary school students learning to make this type of use of computers.
2. To introduce participants to the use of an integrated software package for creating a lab manual and/or writing up lab assignments to be handed out to students. Here the emphasis is on the use of an integrated software package as an aid to teacher productivity.
3. To briefly discuss probeware.

Materials:

Software	***Hardware***
Microsoft *Works* Program disk	Macintosh computers
Microsoft *Works* Data disk	with printers

Handouts

Activity 1: Integrating the Word Processor and Database
Activity 2: Integrating the Word Processor and Spreadsheet
Game of the Week

Resources

overhead projector
overhead markers
refreshments

Setup

Macintosh computers and Microsoft *Works* software should be set up before participants arrive. An appropriate number of the handouts should be placed at each computer work station, along with the needed data disk.

Introduction

One model of instruction is to first teach a person a great deal about a particular topic, and then (perhaps a long time later) give them the opportunity to use the knowledge and skills they have (supposedly) gained (and supposedly still remember). A second approach is, to the extent feasible, fully integrate instruction and application. The NSF inservice series emphasizes the latter approach. It incorporates a relatively modest introduction to certain features of a software package with substantial hands-on use of the features that have been covered. Participants are then strongly encouraged to immediately begin using their new knowledge and skills in their teaching.

The science lab report is an excellent environment to combine learning about a variety of computer applications, and immediately applying this knowledge to accomplish an important task. This "immediate application to accomplish a worthwhile task" is a key underlying theme in the entire NSF inservice series.

Activity I
45 minutes

As participants arrive, get them into pairs on the computers and have them work on Activity 1 and Activity 2.

Debrief
15 minutes

Focus on how giving students good access to an integrated software package might change the nature of the science lab experience. What might be better, and what might be worse? How much science class time might be used up in having students learn to use the integrated software package? Once students gain some computer skill, will they save some time in doing their lab reports? Will having computers available make it easier for students to cheat — for example, by fudging data or copying from other students?

Break
10 minutes

Relax, socialize, enjoy.

Additional Debriefing and Discussion
40 minutes

The role of the lab and the lab report is central to science education. To a great extent, however, many science teachers do not take appropriate advantage of possibilities to give students the chance to actually "do" science. The science lab becomes a cut and dried activity involving little thinking, discovery, hypothesis generation, or hypothesis testing. Science education leaders have known for a long time that science education could be substantially improved by placing a much greater emphasis on "doing and discovering" rather than on memorizing what others have done.

The introduction of computers into the science laboratory environment, and in writing up science lab reports, may not cause a significant change in student or teacher behavior. The goal in this added discussion time is to identify some of the desirable student and teacher behaviors, and to see that computers can contribute to increased appropriate behavior.

One approach is to divide participants into discussion groups of three to four people. Each group is to identify desirable student and teacher behaviors related to the science lab and the science lab report. Then they are to discuss possible impacts of computers on these behaviors. After about 20 minutes, each group is to report its key findings and recommendations. The inservice facilitator can make a list of these findings and recommendations on an overhead.

In conducting this discussion, place the major emphasis on ways to improve science education through changes in the design, conduct, and write up of science labs. The emphasis is not on the computer, nor on using a computer to actually conduct lab experiments. However, the idea of probeware should be mentioned at the beginning of the discussion, and it is appropriate for participants to include it in their discussions. Most likely some of the inservice partipants will have had experience in using probeware, and you will want to take advantage of this source of knowledge.

Closure
10 minutes

Allow some time to discuss the continuing Weather and Moods Game of the Week. Are inservice participants gathering data, and are they beginning to detect patterns in the data they have gathered? Do they have ideas on how to analyze the data, and would they like to share some of their ideas? Also allow time for questions about the term projects. One of today's handouts suggests the desired format for the final project report. Keep the computer lab open for an hour, so that participants can work on activities of their choice. Some may want to work on Activity 3 from last week, which involves creating a spreadsheet. Others may want to work on their term projects.

4.6.3 Timeline

Before participants arrive have the Microsoft *Works* Program disk and the data disk at each computer. Machines will be turned off. Group participants into pairs and direct them to the computer work stations as they arrive.

0:00 - 0:45
45 min

Participants will complete Activity 1 (Integrating the Word Processor and Database) and Activity 2 (Integrating the Word Processor and Spreadsheet). The emphasis is on using these features of an integrated package to do a science lab report. Encourage participants to talk to each other about problems their students encounter in doing science lab reports.

0:45 - 1:00
15 min

Debrief Activity 1 and Activity 2. Place the initial emphasis on questions that participants had in doing the activities. But then switch the emphasis to the science lab report itself, and its role in science education. Lay ground work for the longer discussion that occurs after the break. Try to focus the discussion on the following:

- Increasing the effectiveness of science education.
- Are integrated approaches useful for science students in general?
- Do the goals of integrated use change with student age/competency level?
- Does usefulness vary with content area?
- How can teachers facilitate this type of use?
- How much computer facility is needed to make these ideas practical?

1:00 - 1:10
10 min

Break

1:10 - 1:35
25 min

Break participants into discussion groups of three to four people. Each group is to develop a list of desirable student and teacher behaviors in the context of conducting and writing up science labs. Begin the discussion by mentioning the idea of probeware, and that you have decided to not place much emphasis on probeware in this particular inservice series. Find out if some of the participants have had significant experience in using probeware. If some have, get them to briefly share some of this experience.

The discussion groups are to come up with a list of recommendations on how to improve science education through changes in the design and conduct of science labs. They need not restrict their attention to possible impacts of computers. However, they should avoid placing undue emphasis on using computers to actually collect data and/or to monitor experiments. Probeware is important in science and in science education, but the underlying ideas we are emphasizing here are much more fundamental in science education.

1:35 - 1:55
20 min

Do a whole group debrief on the above discussion activity. Make use of an overhead to collect good ideas and recommendations. Focus some of the attention on how computers might help move teachers and students in the directions that would improve science education.

1:55 - 2:00
5 min

Closure. Make sure that the multi-week game on moods and weather is progressing smoothly. Note that this week's Game handout contains a new Game that is to be done during the coming week. Allow time for questions about the term projects.

4.6.4 Handouts

These handouts are needed during Session 6. The facilitator may want to make some of these into overhead projector foils for use during the inservice.

Index to Handouts **Page**

Activity 1: Integrating the Word Processor and Database 2

Activity 2: Integrating the Word Processor and Spreadsheet 5

Game of the Week 8

Activity 1
Integrating the Word Processor and Database

1. Insert the disks.
    - **Microsoft *Works*** Program disk internal drive.
    - **Microsoft *Works*** Data disk external drive.
2. Selecting the **Kinematics desktop**.
    - Click on the **Drive box** (right side of the screen).
    - Select **Kinematics** by clicking on it once. A box will appear around the icon and title.
    - Click **Open** on the right side of the screen.

    Three windows will appear on the screen: **Kinematics Prelab (WP), Kinematics data (DB),** and **Kinematics calculations (SS).**
3. Activating a window.
    - Click on the title bar of the **Kinematics Prelab** (**WP**).
    - Select **Full Window** from the **Window** menu. The screen should be entirely filled by the **Kinematics Prelab (WP)**.
4. Read sections **I - III** of the **Kinematics Prelab** (**WP**).
    - In your own words state the purpose of the laboratory.

      ____

      ____

      ____

      ____

    - Identify the four equations we will use.

      Distance:

      Time:

      Speed:

      Acceleration:

- What do you think each of the following variables stand for?

d - ______________ t - ______________

s - ______________ a - ______________

- Predict (make a list of) the variables we will *measure* in the laboratory.

- What variables do you think we will *calculate*?

5. Read **Section IV Equipment/apparatus**.

The cart moves across the table as the weight falls. The string is attached to the cart via the pulley. As the weight moves it pulls the paper tape through the timer. The timer marks the tape with dots at preset time intervals.

6. Completing the **Prelab Report**.

- Read the **Anticipation** section of the **Kinematics Prelab (WP)**.
- From the keyboard type in your anticipation or hypothesis.
- Read the procedure.

Suppose you or your students had completed this lab. You would be facing several hours of calculations and graphing. As you complete the activity think about how this affects students' attitudes towards laboratory work.

7. Copying data from the database to a word processing file.

The data from the paper tape has already been entered into the database.

To view the database:

- Select the **Kinematics data (DB)** from the **Window** menu.
- Open the window by selecting **Full Window** from the **Window** menu. Notice this is a simple database with only two fields, but with 23 records.
- Click on 0.00 under **time.** Holding the mouse button down, drag the cursor until all of the data in both columns is selected (i.e., highlighted).
- Select **Copy** (**Caution:** *Avoid the Cut command*) from the **Edit** menu. This makes a copy of the data. It is then available to **Paste** into another application in the integrated package.

To paste the data into the **Kinematics Prelab (WP)** file:

- Select **Kinematics Prelab (WP)** from the **Window** menu.

- Find ***Copy the database here*** in the file (Section V Calculations).
- Click the cursor beneath ***Copy the database here*** and select **Paste** from the **Edit** menu. You have just pasted the data from the database into the word processing document.

Look at the data. Can you support or reject your hypothesis or anticipation? What can you say about the data?

A lot of information is hidden in this data. We can use the spreadsheet to calculate and draw graphs to highlight the results. Activity 2 illustrates this aspect of doing the lab report.

8. Saving changes to a file.
   - Select **Save As** from the **File** menu.
   - Type in the name **Kinematics Lab Report.**
   - Click Save.

Activity 2

Integrating the Word Processor and Spreadsheet

1. Integrating the spreadsheet with database information.

   Examine the spreadsheet calculations done with data from the database:

   - Select **Kinematics calculations (SS)** from the **Window** menu.
   - Select **Full Window** from the **Window** menu. The screen should be entirely filled by **Kinematics calculations (SS)**.
   - To view the formulas, select **Show Formulas** from the **Options** menu.

2. Copying data from the spreadsheet to a word processing file.

   To paste the data into the report, first make a copy of it (just as we did in Activity 1).

   - Select cell **B11** and drag to cell **F37** so that this section of the spreadsheet is highlighted.
   - Select **Copy** from the **Edit** menu. Now we have a copy of the calculations for the report.
   - Select **Kinematics Lab Report (WP)** from the **Window** menu.
   - Find ***Copy the spreadsheet here*** in the document.
   - Click the cursor beneath ***Copy the spreadsheet here*** and select **Paste** from the **Edit** menu.

   You have just pasted the calculations from the spreadsheet into the word processing document.

   Look at the data. Does the data support or reject your hypothesis What can you say about the data?

   The lab report is nearly finished. You have copied and pasted several items: the data collected in the database and the calculations done in the spreadsheet. Graphs will be constructed using the laboratory data to help us understand the relationships among distance, speed and acceleration. While completing the activity *think about how time consuming construction of graphs* is for students.

3. Constructing graphs.

   - Select **Kinematics calculations** (SS) from the **Window** menu.
   - Select **Select Definition** from the **Chart** menu. A dialog box will appear.

- Select **Distance vs. time** and click on **OK**.
- Review the entries and then click **Plot It!**

4. Copying data from the spreadsheet to word processing file.

   To copy the graph:

   - Select **Copy** from the **Edit** menu. You have just made a copy of the graph.

   To paste the graph into the laboratory report:

   - Select **Kinematics Lab Report** from the **Window** menu.
   - Locate ***Copy the Distance vs. time*** graph here, click the cursor beneath it and select **Paste** from the **Edit** menu.

   You can move the graph a little to position it better on the page. Put the cursor anywhere in the graph and an icon of a hand will appear. While holding the mouse button down, move the hand icon and notice how the graph moves. Click outside of the highlighted box to de-select the graph (it will change from black to white when it has been de-selected).

5. Move the graph into view using the scroll bar on the right. A nice curve is plotted. What can you tell from this curve? (Remember that we are interested in how the distance the cart moves changes over time.)

6. Viewing the second graph.

   - Select **Kinematics calculation (SS)** from the **Window** menu.
   - Select **Select Definition** from the **Chart** menu. A dialogue box will appear.
   - Select **Speed vs. time**, and click on **OK**.
   - Review the entries, and then click **Plot It!**

7. Copying data from the spreadsheet to word processing file.

   To paste this graph into the lab report:

   - Select **Copy** from the **Edit** menu.
   - Select **Kinematics Lab Report** from the **Window** menu. Locate ***Copy the speed vs. time graph here***, click the cursor beneath it and select **Paste** from the **Edit** menu.

   You can move the graph a little, as you did in 4. above. Put the cursor anywhere in the graph and a hand will appear. While holding the mouse button down, move the mouse to move the graph. Click outside of the highlighted box to de-select the graph (it will change from black to white when it has been de-selected).

The **Acceleration vs. time** graph has already been copied and pasted into the report. Locate it in the **Kinematics Lab Report**.

8. Finishing the laboratory report.

Use the graphs and the data in the database to complete the report.

- Type in your answers to the questions in part VI.
- Write your conclusions in part VII.

Game of the Week

Select two quite different science labs that you have used with your students. (They can be from the same class, but it might be better if they were from two different classes.)

1. Briefly describe each lab. (Include a photocopy of each lab if you like, but also include a brief written summary.) The written description should include the nature of the class, what you hoped to accomplish by using the lab, and actual outcomes.

2. For each lab, briefly describe how much of the student effort seemed to fall into each of the following categories:

   A. Gaining an initial understanding of what is to be done before moving to the lab facility.

   B. Moving to the lab facility, setting up apparatus, etc.

   C. Conducting the experiment and recording data.

   D. Moving back to a classroom environment, including tearing down the apparatus if this is appropriate.

   E. Writing the lab report.

   F. Other (please specify; for example, doing library research on the lab topic).

Briefly compare and contrast the two labs and the time that students spent on various aspects of the labs. Then discuss how these labs might be affected by students having access to an integrated software package to use in doing the lab report.

4.6.5 Student Materials

This Materials sections of the Notebook contains sample lesson plans and other materials designed for inservice participants to use with their students. This particular section contains two very useful sources of information.

Index to Materials	Page
Help for Computer-Using Chemistry Teachers	2
More News for Biology Teachers	4

Project SERAPHIM:
Computer Resources for Chemistry Teachers

Project SERAPHIM provides chemistry teachers with software and training to get the most out of classroom microcomputers. This National Science Foundation-funded program was founded in 1982 at Eastern Michigan University. It is now based at the University of Wisconsin.

There are three programs within Project SERAPHIM: software, teacher training, and research and development. SERAPHIM offers nearly 700 programs on disk, covering a wide range of chemistry topics. Supported hardware includes Apple II, IBM PC, Macintosh, Commodore PET/C-64/C-128, and Radio Shack Models I and II. Most Macintosh disks cost $10.00, while most disks in other formats cost $5.00. Program documentation materials are available for $2.00-$10.00. A 100-page catalog and smaller supplement are free.

Project SERAPHIM education activities include workshops, training sessions, and symposia. Subjects include such activities as building electronic probes for interfacing with computers, and adapting integrated software packages to the science classroom. Workshops are led by high school science teachers from around the country. Project SERAPHIM participants can communicate with one another on the CHYMNET telecommunications network.

Research and development efforts encourage teachers and programmers to create innovative software for chemistry education. Annual and summer fellowships allow educators to pursue this work at the Project SERAPHIM headquarters.

A quarterly newsletter provides current information on project activities. Contact Project SERAPHIM, Department of Chemistry, University of Wisconisn, 1101 University Avenue, Madison, WI 53706, 608/263-2837.

More News for Biology Teachers

The Biological Sciences Curriculum Study (BSCS) is working to prepare science teachers to implement educational technologies effectively. With support from the National Science Foundation, BSCS has developed a curriculum, ENLIST Micros, for training teachers to use microcomputers to enhance learning and teaching in science and is developing and testing strategies to facilitate the implementation of educational computing in precollege science education.

BSCS staff will disseminate information about ENLIST Micros at short courses at the national and regional conventions of the National Science Teachers Association (NSTA) and at the national convention of the National Association of Biology Teachers (NABT). The all-day short courses are designed for educators of preservice and inservice science teachers, including faculty at colleges and universities and state and local science supervisors. Registration information is available from NSTA and NABT.

During the short courses, project staff will share what they have learned from five years of developing and evaluating strategies for implementing educational technologies for implementing educational technologies in science classrooms. Science educators completing the course will be provided materials and procedures for establishing implementation networks in their regions.

For more information about ENLIST Micros, contact: BSCS, 830 North Tejon Street, Suite 405, Colorado Springs, CO 80903.

4.7

Session 7: Investigation of Some Commercially Available Science Education Software

7.1 Narrative Overview

The number of computers available for use in schools is gradually growing. Common estimates for the academic 1988-89 school year suggest that there was about one microcomputer or computer terminal for every 20 students during that year. The typical high school now has one or more computer labs. Many schools (indeed, some states) now require all students to obtain an introductory level of computer literacy. There, most often, students learn to use a word processor and get an opportunity to experience use of a variety of other applications software.

Progress in integrating the routine use of computers into science education has been spotty. As indicated early in this book, the overall field of instructional use of computers can be divided into three main components. These are teaching and learning about, using, and integrating computers. A few key ideas related to each of these types of uses in science education are given below.

1. Teaching and learning about computers: At the college and university level the typical science faculty member knows how to write computer programs and has a reasonable level of understanding of the rudiments of computer science. For example, many faculty have an understanding of interfacing computers with laboratory equipment. Quite a few are skilled in designing such interfaces and using them in the online monitoring of experiments.

   Most often the programming and computer science knowledge of college science faculty is self taught, or has been obtained through participation in workshops and short courses. Younger faculty typically have had computer programming and computer science courses while they were in college, or even earlier in their schooling. Moreover, it is now quite common to expect that undergraduate science majors will learn to program, either on their own or through taking several computer science courses. In the more applied science areas, such as engineering, students are typically required to gain a substantial level of skill in writing computer programs.

   In a typical college setting, science majors have reasonably good access to computers. Their faculty expect that they will use the computers when appropriate. Relatively little science class time is devoted to helping students learn more about computers. However, it is common to give assignments that require computer programming skills and other computer science knowledge to complete in a reasonable time frame.

   At the precollege level, only a modest percentage of science teachers know how to write computer programs at a functional level. Computers are not readily available for use by students in science classes, and relatively few students have computer programming skills that would help them in the classes. Thus, relatively few secondary school science courses require or make use of activities in which either the students or the teacher must write computer programs or display a reasonable level of understanding of computer science.

2. Learning and teaching using computers; computer-assisted learning (CAL): There is a substantial amount of CAL materials specifically designed for use in science education. It ranges from routine drill and practice to a variety of tutorials to quite sophisticated simulations. Use of such software is gradually growing, although the main emphasis remains at the drill and practice end of the scale.

   The use of computer simulations as a replacement for science labs or as a supplement to science labs has been discussed by science educators for many years. Those who support the use of simulations argue that they are safe (we don't want kids playing around with a nuclear reactor) and inexpensive. Those who oppose such use argue that we have little evidence of transfer of learning from the simulation to the "real thing" and that students using the simulations are not developing needed laboratory skills.

Where adequate computer hardware and software facilities are available, a middle of the road approach tends to prevail. Students make use of computer simulations, and they continue to do hands-on experiments in the science lab. A carefully crafted combination of these two approaches seems likely to be better than over-emphasis on either extreme.

3. Learning and teaching integrating the computer as a tool into the curriculum (CII): This book, and the specific 8-session inservice described herein, focuses primarily on CII. The authors strongly believe that all students in science courses should routinely use computer application tools such as databases, presentation and mathematical graphics, spreadsheets, word processors, and mathematical packages for equation solving, statistical analysis, etc. It is evident that routine use of such tools would have a substantial impact on the content and pedagogy of science education. It is hoped (but we lack good research evidence) that the changes would lead to students gaining a better understanding of science and how to do science.

   A rapidly growing number of students learn to use a few of the computer tools while they are in middle school or junior high school. This is laying the groundwork for high school science teachers who want to integrate tool use of computers into their courses. In many high schools there are now quite a few students who make routine use of computers. This is a valuable resource to high school science teachers who want to do CII. The students can learn from each other (paired learning or cooperative learning can be quite successful) and relatively little of the science education class time needs to be devoted to having students learn to use computers.

Session 7 of the NSF inservice is devoted to examining some of the CII software that is commercially available. Software to be examined may range over all three general categories of instructional use of computers. However, you may want to focus attention on probeware, simulations, and science application packages that are readily available to the participants in your inservice.

Several organizational approaches have proven quite successful in inservice settings. For example, the inservice participants can be divided into teams during Session 6, and each team can be given a piece of software to study during the week. Then each team is made responsible for staffing a "learning station" during Session 7. Participants spend Session 7 visiting a number of learning stations where they try out the software with the help of their fellow teachers.

An alternative approach is still more individualized. Each participant is given a piece of software to learn, with instructions that their goal is to be able to teach its use to inservice participants like themselves. Then Session 7 is devoted to one-on-one teaching, with each participant teaching one or more others how to use their particular piece of software, and in turn receiving instruction on how to use some other piece(s) of software. This is a very good approach, and it is apt to carry over to the participants' schools.

Still another approach is to select one or more pieces of applications software that are different from the software that has been used so far in the inservice series. All participants learn to use this new software, and group discussions focus on it. If that approach is used, it might be well to also give some instruction in the evaluation of software. What does one look for when examining a new piece of software? How can one tell good software from software that is not so good?

Of course, part of the answer lies in making appropriate use of work done by others. A number of computer magazines carry software review columns. The Computing Teacher (published by the International Society for Technology in Education) regularly includes a science section and often includes reviews of science-oriented software. The professional society journals for each area of science education often contain computer-oriented articles and reviews of software. This week's Game of the Week focuses on having participants explore some of these resources.

4.7.2 Script
4.7.3 Timeline

The Narrative Overview suggests a number of possible organizations for this session. Since this session is nearly all hands-on, its design and conduct is quite easy. Therefore, we have not provide a detailed Script or Timeline.

Section 4.7.4 Handouts contains materials that can be used for a whole group focus in Session 7. These materials include a Database Software Evaluation Form developed by students in a computers in education course on databases at the University of Oregon. Of course, there are a number of general purpose software evaluation forms available. This one is specialized to a particular type of software.

During the three year National Science Foundation project, inservices were also designed and conducted for Elementary School teachers, Secondary School Mathematics teachers , and Secondary School Social Studies teachers. All three of these inservices used the Apple II series of computers. This focus on the Apple II series was because most of the participants were teaching in schools having this equipment.

However, the NSF project team chose to use Macintosh computers and the Microsoft *Works* software for the Secondary School Science inservices. This was a hard decision to make, because we knew that relatively few of the participants had access to Macintosh computers. Thus, most did not have the opportunity to take the activities being done during the inservice and apply them directly in their classrooms. The decision to use Macintosh computers was based mainly on our desire to be "forward looking" rather than "backward looking." At the time the project started, relatively few science teachers were making CII use of computers and relatively little computer equipment was readily available to science teachers. We decided to develop inservice ideas and materials that would fit the growing and changing needs of this particular inservice area, and that would have a relatively long life span.

The decision to use Macintosh computers violated a number of the key ideas for the design of an effective inservice. Research strongly supports the contention that teachers need specific training and practice on the materials and equipment that they are to use in their classrooms. Relatively few teachers can transfer learning about a sophisticated hardware/software facility during an inservice, to implementing the underlying ideas with quite different hardware/software in their own classrooms.

We attempted to compensate for our "forward looking" Macintosh decision in several ways. First, we placed substantial emphasis on the underlying science education concept that science hinges on hypothesis generation and hypothesis testing. The generation and testing of hypotheses does not require access to computers. Second, we included a reasonable number of off-machine activities in the inservice series. These could be used directly by inservice participants in their classrooms. Third, we were aware that a number of the participants had previously used Apple II or other types of microcomputers. We strongly encouraged them to continue to do so, and to translate inservice ideas from the Macintosh to these other machines. Fourth, we devoted Session 7 to hands on activities using Apple II equipment. Fifth, we encouraged participants to do their term projects on the hardware and software available for use in their schools.

4.7.4 Handouts

These handouts are needed during Session 7. The facilitator may want to make some of these into overhead projector foils for use during the inservice.

Index to Handouts	**Page**
Introduction to Sunburst Communications Endangered Species Databases	2
Database Software Evaluation Form	8
Game of the Week	10

Introduction to Sunburst Communications Endangered Species Databases

The *Endangered Species Databases* contain the following database files:

Mammals: information on the condition of life, the location, and problems of endangered mammals in the United States.

Critical: information on the world's most endangered animal species, including vertebrates and invertebrates.

Extinct: a listing of extinct species of birds, mammals, reptiles, and amphibians from 1600 to the present.

Books: recommended fiction and nonfiction about endangered or extinct animals, categorized by age, subject, genre, animal, author, and title. Students and teachers are encouraged to add new books.

Glossary: a glossary of terms pertinent to one or more of the *Endangered Species* databases. Students are encouraged to add new words.

Local: a database that students build to examine the status of threatened and endangered wildlife in their state or region.

Evaluation of Endangered Species Database Activity

In this activity you will assume two roles: a) science student, b) teacher/evaluator of curriculum materials.

Science Student Activity

The inservice facilitator will model an appropriate use of one computer with a large screen projection device. The software will be the Sunburst Communications *Endangered Species Databases*. During the demonstration, please assume the role of a science student. Before the demonstration begins, please do the following activity.

Put a check next to the hypothesis that best describes why mammals in the United States are added to the threatened or endangered species list.

- Killing mammals viewed as pests (persecution) is the major reason mammals become threatened or endangered.
- Habitat loss is the major reason mammals become threatened or endangered.
- Hunting is the major reason mammals become threatened or endangered.
- Pollution is the major reason mammals become threatened or endangered.
- Humans disturbing mammals in their natural environment is the major reason mammals become threatened or endangered.
- Poisoning is the major reason mammals become threatened or endangered.

The handouts given below are typical of those that might be used in whole class and/or small group activity with the Sunburst Communications Endangered Species Databases. Use these as seems appropriate during the demonstration being presented by your inservice facilitator.

Endangered Species Data Collection Sheet I

	Number of records
Habitat Loss	______
Human disturbance	______
Hunting	______
Persecution	______

Poisoning ______

Pollution ______

In two or three sentences write a new hypotheses that describes why mammals are added to the threatened or endangered species list.

____

____

____

____

Endangered Species Data Collection Sheet II

Organizing data in a list format may help you recognize patterns or trends that can help you confirm, deny, or modify your newest hypothesis. (Note: At this stage of the whole class demonstration, it is assumed that the class has been divided into groups and each group has received an appropriate printout of part of a database.)

1. Creating a list format.

Each group has a printed report of the records selected by the computer for each **Problem area** (habitat loss, human disturbance, hunting, persecution, poisoning, and pollution).

- Review the printed reports. If a mammal's name appears in the report, put a check (√) in the appropriate category on Data Sheet II.

2. Looking for patterns and trends.

Examine the list.

- In two or three sentences write a new hypothesis that describes why mammals are added to the threatened or endangered species list.

____

____

____

____

3. Generating a hypothesis.

There may be a relationship between the problem **Hunting** and the types of mammals affected by it.

- As a group generate a new hypothesis that might describe this relationship.

- In two or three sentences explain which organization of data was most useful in helping you confirm or deny the new hypothesis.

Endangered Species Data Collection Sheet III

1. In this activity you will select records from a database to help you confirm or deny a hypothesis.

- In your group, generate a hypothesis that describes the state with the largest number of threatened or endangered mammals. Write your hypothesis in the space provided.

2. Generating New Hypotheses.

- Select one state you wish to explore in greater detail. Use the names of the mammals on **Data Collection Sheet II** to predict the types of mammals most likely to be threatened or endangered in the state selected by your group. Write your hypothesis in the space provided.

____

____

____

____

3. Testing hypotheses using a database.

To test your hypothesis, we will select out the records of mammals endangered in each state.

- On the map provided indicate the number of threatened or endangered species for each state.
- If the records selected relate to your second hypothesis, note the types of mammals endangered in that state. Does this information help you confirm or deny your hypothesis? Use the information on Data Collection Sheet II to help you generate additional hypotheses.

Teacher/Evaluator Activity

Following completion of the whole class database exercise, you will evaluate the activity in three different ways. Do this working in groups of three or four.

A. Bloom's Taxonomy of Educational Objectives: How much of the emphasis in the demonstration lesson was aimed at each of the six levels in Bloom's Taxonomy?

1. ***Knowledge:*** Simple recall of information.
2. ***Comprehension:*** The lowest level of understanding.
3. ***Application:*** Using abstractions and principles in specific situations.
4. ***Analysis:*** Distinguishing and comprehending interrelationships.
5. ***Synthesis:*** Rearranging ideas into new wholes, creating new structures.
6. ***Evaluation:*** Making judgments based on internal evidence of external criteria.

Lindgren, H. C. (1980). *Educational Psychology in the Classroom* (6th ed.). New York: Oxford University Press.

B. Gagne's Conditions of Learning: How much of the emphasis in the demonstration lesson was aimed at each of the eight types of learning in Gagne's list?

1. ***Signal learning:*** Classical conditioning; involves involuntary responses.
2. ***Stimulus-response (S-R) learning:*** Operant Conditioning.
3. ***Chaining:*** Combinations of sequential S-R responses.
4. ***Verbal association:*** Like chaining, but the links are verbal units.
5. ***Discrimination learning:*** Recognition of similarities and differences among stimuli.
6. ***Concept learning:*** Responding to abstract characteristics in classifying stimuli.
7. ***Rule learning:*** Combinations of concepts.
8. ***Problem solving:*** Using rules to achieve end goals in a variety of situations.

Gagne, R.M. (1985) *The conditions of learning and theory of instruction*. (4th ed.) New York: Holt, Reinhart and Winston.

C. CI^3 model. How well did the demonstration instructional unit adhere to the ideas that have been emphasized throughout the inservice series?

Database Software Evaluation Form

Name: ______________________________

Publisher: ______________________________

Cost: ______________________________

Hardware Requirements:

Make/Model of Computer: ______________

Number of Disk Drives Required: ______________

Minimum Memory Required: ______________

Recommended Grade Level: ______________

Maximum number of fields per record: ______

Maximum number of screens per record: ______

Maximum field length (# characters): ______

Maximum number of records per file: ______

Yes	No	
		General Characteristics
☐	☐	Program is easy to get "up and going"
☐	☐	Program is copy protected
☐	☐	Publisher permits multiple copying and/or multiple loading
☐	☐	Site license available
☐	☐	Data is disk based (vs. memory based)
☐	☐	Menu is icon driven
☐	☐	Minimal simple mnemonic commands
		Documentation/Tutorial/Help
☐	☐	Well organized, readable documentation
☐	☐	Tutorial included
☐	☐	Tutorial of value
☐	☐	Sample database files included
☐	☐	Help screens available
		Data Entry
☐	☐	Saves data as it is entered
☐	☐	Custom screen layouts available

Yes	No	
		Field Formatting
☐	☐	dollar format
☐	☐	%
☐	☐	scientific notation
☐	☐	calculated fields (within a record)
☐	☐	calculated fields (between records)
☐	☐	set decimal lengths
☐	☐	automatic date and/or time
☐	☐	graphic fields
☐	☐	logical fields (Yes/No)
		Data Manipulation
☐	☐	Sorts data (simple sort only)
☐	☐	Sorts data by multiple fields
☐	☐	Searches for string or value
☐	☐	Selects records (Number of search criteria = _____)
☐	☐	Record selections include AND, OR, NOT, THROUGH
☐	☐	Record selections include arithmetic operators (<, >, =, ≠)
☐	☐	Easily scans all records
☐	☐	Displays all records in a list on the screen
☐	☐	Displays individual records
		Data Output
☐	☐	Outputs tables
☐	☐	Outputs individual records
☐	☐	Outputs to screen
☐	☐	Customized layout to printer (delete, insert fields.)
☐	☐	Custom layouts can be saved
☐	☐	Outputs graphics (if graphics are used)
☐	☐	Supports different fonts
		Additional Features
☐	☐	Graphing capabilities within program
☐	☐	Graphing capabilities with separate program
☐	☐	Files can be transferred to a spreadsheet
☐	☐	Commercially produced database files are available
		Recommendations
☐	☐	I would recommend this database for student use in: ☐ high school ☐ middle school ☐ elementary school
☐	☐	I would recommend this database for use by teachers.
☐	☐	I would recommend this database for use by administrators and /or office staff.

Note: This form was developed by students in CI 410 Introduction to Databases, University of Oregon, Summer 1987.

Game of the Week

Part 1

You have completed seven of the eight inservice sessions. The sessions have provided you with information about how the computer can be integrated into the science curriculum. Hands-on and off-computer activities have provided you with an environment to explore and become more familiar with the computer as a teaching tool.

At this time we would like you to get comfortable, and take a few minutes to relax. Once relaxed, imagine the ideal science classroom. You might consider some of the following: the physical set-up, available equipment, curriculum offerings, teacher instructional style, goals, etc.

After you have established a mental picture, write it down. The description can be in any form you like: short paragraph(s), an outline, a list of notes and/or comments, or diagram. The goal of the exercise is to provide a description of your ideal classroom environment.

Remember: There is no right or wrong answer. You are an experienced classroom teacher and we are interested in what you consider is the ideal classroom working environment. (Of course, you should be somewhat realistic!)

Part 2

The educational use of computers is changing very rapidly. Since computers are very important in science and in science education, it is important that all science teachers both learn about this field and learn how to keep up in this field. An inservice is a good way to get started. What is needed after that is a continuing source of new information and ideas. Probably the best sources are the publications of the professional societies for science educators.

During the coming week, browse through a half dozen recent issues of science education periodicals. Select from at least two different periodicals. Then:

1. Write a brief summary of the nature and extent of computer education-related articles and software reviews included in the periodicals. Include a brief comparison among the two or more different periodicals that you examined.

2. Select an article or a set of software reviews that you feel is particularly appropriate to the participants in the inservice. Make copies for each person in the inservice.

4.8

Session 8: Projects and Closure

4.8.1 Narrative Overview

The last session can be devoted to a range of activities. Some suggestions:

1. Sharing the results of last week's Game of the Week. Each participant is supposed to have made enough copies of some article for each person in the inservice. As time permits, each participant can give a one minute summary of why they picked the particular article that they picked, and its key ideas.
2. Group presentations of projects.
3. Discussion of results from the "Weather and Moods" multi-week Game of the Week project.
4. Group participants by schools, and allow some time for the groups to do planning for where their school is headed in terms of increased appropriate use of computers in science education and/or throughout the whole school curriculum.
5. Whole group discussion on how to coordinate computer use in the middle schools or junior high schools with computer use in the high schools. What would the high school science teachers like students to have learned about computers before they get to high school?
6. Closure. The inservice facilitator might present a brief summary overview of what has been accomplished and what followup support is available. The inservice participants have developed a strong level of mutual support. What will be done to continue this mutual support?
7. Evaluation. Remember, evaluation is to be done in a fashion that protects the individual participants. It is most desirable that someone other than the inservice facilitator conduct the evaluation and collect the data. The inservice facilitator should only receive summary statistics from the evaluation data.

   Recall that during the first session, participants filled out and handed in a form labeled **Participant Objectives (A Formative Evaluation Instrument)**. Hand back these forms, and have each participant complete his/her own form. Then, as appropriate, make use of some of the other formative and/or summative evaluation instruments given in the latter chapters of this book.

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by Sharon Burrowes Yoder

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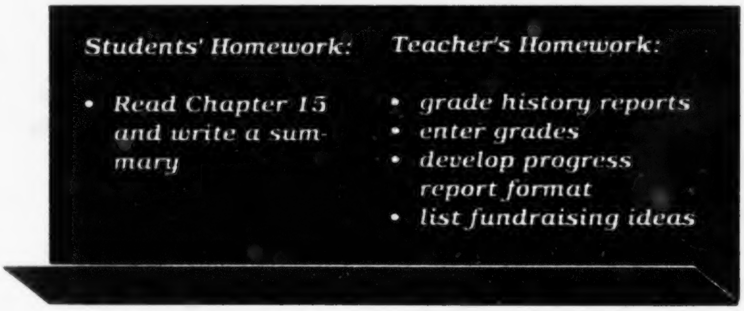

Students' Homework:

- *Read Chapter 15 and write a summary*

Teacher's Homework:

- *grade history reports*
- *enter grades*
- *develop progress report format*
- *list fundraising ideas*

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ef•fec•tive\i-'fek-tiv\adj (14c)

1 a : producing a decided, decisive, or desired effect b : IMPRESSIVE, STRIKING
2 : ready for service or action

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INSTRUMENTS AND EVALUATION

5.1

Evaluation Overview

Rational for Evaluating Inservice Programs

The planned outcome of many inservice programs is a set of changes in attitude or behavior. While formal evaluation provides staff developers with a useful tool in planning, designing, developing, and implementing of staff inservice, "systematic evaluation of inservice programs is the exception rather than the rule" (Gall & Renchler, 1985, p. 28). The literature survey conducted by Vivian Johnson (1988) for her Ph.D. dissertation indicated that very few inservice projects are adequately evaluated either while they are being conducted or after they have been conducted. That is, very few inservice facilitators gather data that could be used to judge the effectiveness of their work.

There is a substantial literature on effective inservice practices. In addition to Johnson (1988), a good starting point for the novice student of this field is Wade's (1984-85) meta-analysis of 91 inservice studies. There is a very substantial bibliography in Joyce and Showers (1988). A number of effective practices identified by Stecher and R. Solorzano (1987) are listed in Table 1 given on the next page.

Evaluation studies provide staff development personal with a mechanism for judging the effectiveness of a program. The evaluation processes is divided into two components: formative and summative. A key point to remember is that the development of formative and summative evaluation plans should always occur in conjunction with the planning, design, and development of inservice programs.

Formative evaluation concentrates on measuring the immediate success of the program. It begins with a needs assessment. Then as the project continues, it provides feedback for the improvement and development of the ongoing activities. Goals of a formative evaluation include:

1. Developing a permanent record of conditions prior to inservice. (This use also needed for summative evaluation, since it provides a baseline for measuring change.)

2. Determining staff development required for improvement of the school, curriculum, etc.

3. Ensuring the inservice program is implemented as effectively as possible.

4. Identifying unanticipated outcomes.

Of the objectives listed, developing a record of pre-inservice conditions is typically eliminated from evaluation plans. This occurs because plans for formative evaluation are neglected until inservice is about to be implemented or is in progress. But without a record describing the pre-inservice conditions, it is difficult to determine the type or degree of change that occurs during and following an inservice. This impacts judging the overall effectiveness of a program (summative evaluation), especially when the expected outcomes of an inservice are changes in participant attitudes, behaviors or values.

While formative evaluation is valuable, it provides little insight about the factors that affect institutionalization—that is, long term acceptance and implementation—of a change (Fullan, 1982). To determine the long term changes that are maintained following inservice requires summative evaluation. Summative evaluation is also used for accountability, certification, selection or continuation of an established program. It concentrates on measuring the **residual effect** of the program over time (6-12 months or more after the project has ended). Unfortunately, summative evaluation is typically neglected.

Table 1: Effective Computer Inservice Practices

1. Extensive practice with computers.
2. Comfortable and relaxed atmosphere.
3. Appropriate balance between lecture and guided practice.
4. Individual attention.
5. Knowledgeable trainers.
6. Detailed curriculum guides and lesson plans.
7. Clear and relevant objectives.
8. Lesson-related materials and handouts.
9. Inservice lessons linked to instruction.
10. Peer interaction.
11. Voluntary participation.
12. Strategies for teaching heterogeneous classes.

From *Characteristics of effective computer in-service programs*. by B.M. Stecher and R. Solorzano, 1987, Pasadena, CA: Educational Testing Service. Copyright ©1987 by Educational Testing Service.

Why should you be interested in the residual effect? After all, formative evaluation can be designed to measure specific content, skills, or instructional strategies learned by participants during the inservice. But, unfortunately, research indicates that knowledge, behaviors, and skills acquired during inservice are seldom transferred to classroom situations. The problem is that without examining the residual effect over time (longitudinal formative or summative) you are unable to determine the overall effectiveness of your inservice program.

A major goal in summative evaluation is to produce accurate descriptions of the program along with measures of its effects (i.e., changes in participant attitude or behavior). These descriptions are valuable for a number of reasons. Typically the program description includes estimations of program cost and helps decision makers determine if the program is worth continuing based on its costs. Program description can also serve as planning documents for people wanting to duplicate the program or adapt it to another setting. Program descriptions also document where you started from, your current state, and where you want to or plan to go. Including descriptions of where you plan to go ties summative evaluation to the first stage of formative evaluation, the needs assessment process.

A final and neglected use of evaluation is for improving recycling of inservice programs. Many inservice providers present their inservices several times per year over a period of years. Keeping track of what presentations go well, what software is useful and the needs of those in the workshop make it easier to improve the next cycle.

Stecher and Solorzano (1987) identify two problems that result from the lack of evaluation research. One, without evaluation research it becomes difficult to judge the relative merits of inservice programs (summative evaluation). Two, without evaluation research, developers have little data to guide them in developing new programs and improving existing ones (formative evaluation).

Planning for evaluation encourages developers to operationalize the goals, objectives, and outcomes of an inservice program. The process of operationalizing encourages developers to divide the change into smaller pieces thus avoiding the pitfall of trying to accomplish a complex change in one step. Evaluation is a constant reminder that change is difficult, complex, and takes a long time.

Current State of Computer Inservice Evaluation

A review of the literature indicated the majority of computer related inservice is not evaluated. When evaluation does occur, it is usually on a small scale and is "one shot," taking place during or within several days of the inservice. The most frequent evaluation goals are determining modifications required for program improvement, making quantitative judgments of whether inservice occurred, and validating that funds were spent on the development and/or initiation of the proposed program or course.

The two most frequently used criteria for measuring the quality of an inservice program are:

1. Changes in participant attitude toward computers.
2. Changes in participant computer literacy or knowledge/skills about particular aspects of using computers.

The selection of these criteria is based on the notion that as participants develop a higher level of computer literacy and knowledge/skills, and positive attitudes toward computers, they will increase their classroom use of computers. *The limited research does not support this notion*! This is a very important point. An inservice can be quite effective in increasing teacher knowledge and skills in the computer field, and have little impact on the teacher's students.

Studies by Vockell & Rivers, 1979, Mitchell, 1986, and Van Walleghem, 1986, suggest that positive attitude toward computers and computer literacy does not have much to do with classroom use of computers. The longitudinal follow-up completed by Vockell and Rivers (1979) indicated that participants completing an introductory computer course subsequently tended not to use computers in their classrooms. Subjects attributed their non use of computers to lack of access rather than a lack of knowledge on how to use them.

Two studies addressed the relationship between changes in teachers' willingness to use computers following inservice and actual classroom use of computers (Mitchell, 1986; Van Walleghem, 1986). These studies indicated that while teacher willingness to use computers increased following inservice, this willingness did not correlate well with actual computer use in the classroom.

Planning to evaluate a computer related inservice

The evaluation of a computer related inservice should be designed to measure the extent that inservice objectives were achieved, identify problems associated with implementing the inservice objectives in the classroom, and measure the long term effect of inservice objectives on student achievement. The evaluation plan should contain two phases, formative and summative, with approximately equal amount of time and effort allocated to each.

Summative evaluation should focus on:

1. Participant knowledge about computers. (Is there a change that can be attributed to the inservice?)
2. Participant attitude toward computers. (Is there a change that can be attributed to the inservice?)
3. Participant instructional and professional use of computers. (Is there a change that can be attributed to the inservice?)
4. Changes in the instructional use of computers by the students of the inservice participant. (Is there a change that can be attributed to the inservice?)

Pre and post questionnaires are effective instruments in measuring changes in participant knowledge and attitude, but remember that increased willingness to use computers does not correlate well with actual computer use in the classroom. If the goal of your inservice is to increase classroom use of computers, your evaluation plan must use additional criteria besides changes in participant knowledge and attitude.

Longitudinal evaluation is the only way to determine if sustained changes in classroom use of computers have occurred following inservice. The evaluation should use of a multi-method approach, including both quantitative and qualitative measures. The multi-method approach helps expose the numerous factors (access to computers, lack of administrative support, teachers not seeing a value in the innovation, etc.) that inhibit or prevent teachers willing to use computers from actually doing so. Measuring changes in classroom use of computers requires base line data on instructional use of computer use prior to the inservice. Changes in computer use that occur during formative evaluation are insufficient to judge the extent of computer implementation in the classroom. It is necessary to use longitudinal, summative evaluation techniques to see if gains made during an inservice program are sustained.

Summative evaluation also serves other purposes. Plans for longitudinal evaluation are evidence of an institution's long term commitment to implementation of the innovation (it simply is not going to fade away). Identification of factors that impact on the residual effect of inservice can facilitate making changes in the culture and organization of the school necessary to maintain the innovation. Fullan and Pomfret (1977) believe the main problem in implementing curriculum innovations is "that curriculum change usually necessitates certain organizational changes, particularly changes in roles and role relationships of those organizational members most directly involved in putting the innovation into practice. …Often the organizational (role relationship) change aspects of curriculum projects are left implicit in the plans (p. 337)." Longitudinal evaluation makes explicit the organizational and cultural changes that must occur for computers to become an everyday instructional tool. Only when these changes are made explicit can they be addressed in an overall plan for staff development.

Selection of an evaluator

In an ideal situation the use of an outside evaluator to assist in the planning, design, and development of an inservice program is highly recommend. This is especially important if the inservice developers have little experience with evaluation and/or if the inservice is to be presented more than once. An evaluation expert can anticipate generic problems associated with the evaluation process and help train inservice personal in the development of an evaluation plan.

An unfortunate reality is that many inservice projects may not have the resources to obtain the services of an external evaluator. This places the evaluation component in the hands of inservice developers. If inservice personal are unfamiliar with evaluation process, they should solicit as much help as they can from experienced evaluators. It is recommended that the draft evaluation plan be submitted to an external evaluator for review and comment, even if the external evaluator cannot participate in the development and implementation process. No matter who ends up planning and conducting the evaluation, the process should occur in conjunction with the initial planning stages of the inservice.

Role of local evaluator

The primary role of the local evaluator is to gain consensus on the decision to evaluate, and to plan and implement the evaluation. When planning the evaluation, it is necessary to gain administrative and participant support for the process. Typically this requires persuading people of the value of evaluation and dispelling its negative image. A large body of research supports the need for continuous evaluation of any change effort (the change process, models of effective staff development, and innovation and implementation attempts).

Gaining administrative support is especially helpful, particularly when additional resources are required to conduct the evaluation. Participant support is critical and cannot be taken for granted. Prior to the inservice—that is, during the needs assessment interaction with potential participants—discuss the value of evaluation in helping to judge the reasonableness of inservice objectives, in assessing reasonable timelines for integrating computers in the classroom, for assessing the extent of resources necessary for this change to occur, and for helping administrators keep in touch with the actual realities of a classroom situation. Remember that participants may be distrustful of the evaluation process, so try to allay their fears. Creating an atmosphere conducive to evaluation should occur with planning what to evaluate.

Evaluation objectives and topics

Inservice evaluation should address the content of the inservice, the presentation of the material (that is, the quality of work being done by the inservice facilitator), changes in the participants, and impact on the students of the participants. Impact on students is the most difficult to determine. It should not be attempted on a formal level (summative evaluation) until a certain predetermined level of classroom computer use is documented. That is, measuring the impact on students of a computer inservice for teachers, is a complex and demanding task. It requires careful collection of baseline data (where the students are at the beginning with respect to the types of changes being fostered through the inservice).

Computer inservice is a new area. Little agreement exists among educational computer experts as to the most appropriate scope and sequence for computer related inservice. The small body of existing evaluation research is helpful in guiding the planning and design of computer inservice, but there is a word of caution. Use the research as a guide, but also tailor the inservice content to reflect the unique nature of your school district, and its long and short range computer goals. Ideally, inservice would be closely tied to carefully developed plans for instructional use of computers in schools that have been developed by the schools and districts of the educators who will participate in the inservice. The planning process is part of the needs assessment effort.

Formative evaluation occurs simultaneously with the initial needs assessment, the initial planning, and the actual conduct of the inservice. A growing body of literature on effective inservice practices and effective computer inservice practices is starting to surface (refer to Table 1). Inservice developers should use this limited research to guide their development of inservice delivery systems. Practitioners can also help the field of educational computing by making systematic studies of which techniques are the most effective and under what conditions.

Table 1 lists a number of possible areas for formative evaluation. That is, the inservice facilitator may decide to implement a number of the suggestions given in that table. Formative evaluation can help the facilitator to determine how well such a decision is being implemented.

Formative evaluation prior to and during the inservice measures how well the content met the current needs of participants. Longitudinal formative and summative evaluation determines when specific inservice programs are outdated and new ones need to be developed. It is important to remember that the goals of computer education are changing. The direction and content of computer related inservice will require careful monitoring to ensure it meets the needs of teachers, and is continually updated to reflect changes in the field.

Determining the content of a computer inservice typically begins with a needs assessment. The needs assessment process can be viewed as a special type of evaluation. The goal of needs assessment is to describe what you want the final state to be, assess the current state, and determine if their is a discrepancy between the two. If a discrepancy exists, intervention is necessary. Inservice is a common component of the intervention process.

The introduction of any innovation requires an assessment of the staff skill level with regards to the innovation, staff attitude toward the innovation, and the characteristics of the school climate that impact on implementation of an innovation.

A formal formative evaluation plan typically includes pre and post questionnaires to determine participant knowledge and attitude. This approach is quick and efficient but lacks descriptive detail, provides little evidence on participant computer skill level, and provide little insight into the problems teachers face when trying to use computers in the classroom. Combining questionnaires with informal approaches results in a richer description and may identify unanticipated problems or concerns. Informal approaches include engaging staff in informal conversations and structured interviews, attending staff meetings, and talking with administrators.

Assessment of participant initial skill level is both a delicate issue and difficult. Most inservice teachers object to the idea that they might be given tests of their knowledge and skills in an area such as instructional use of computers. This suggests that instead one should use observational techniques. These should include unobtrusive observation (walk-bys of teacher classrooms, noting who is using school computer facilities, sign out sheets for mobile computers, department requests for software and hardware) and obtrusive observation (classroom visitations). An excellent reference on unobtrusive evaluation techniques is Webb et al (1966).

Currently there is little theoretical basis for the development of effective computer related inservice. Without the development of this knowledge, staff developers will continue to reinvent the wheel every time they need to conduct computer related inservice. Documenting, through evaluation, the successes and failures can help us build a common knowledge base useful to both researchers and practitioners.

Magnitude and extent of the evaluation

The appropriate magnitude and extend of an evaluation is dependent on the magnitude of your staff development goals for integrating computers into the classroom. Small and simple goals requires smaller evaluations, while complex goals require substantial evaluation efforts. As a very rough rule of thumb, you might think of spending approximately ten percent of the inservice time, effort, and money on evaluation.

Longitudinal evaluation is a systematic way to detect permanent changes in participant behavior, the types of changes, and if the changes were the anticipated ones. Measuring changes in participant behavior enables you to assess the level of implementation that has occurred following inservice. Determining the level of implementation is important because with complex changes (such as increasing in-class computer use) staff developers frequently under estimated the time required to bring about a permanent change. Remember, evaluation of the impact on students can not be determined unless some predetermined level of in-class computer use has been achieved.

To date, most evaluation efforts have been small scale and short term. These evaluations concentrate on measuring the appropriateness of inservice content and materials, the effectiveness of the delivery system, and immediate changes in participant attitude, knowledge, or skill level occurred. This information is especially important when developing new inservice programs. However, without knowledge of the long-term residual effects, it is difficult to determine what changes occurred and if they were maintained. This prevents staff developers from systematically planning what should be done next or what additional interventions are necessary before moving on.

Collecting evaluation data

One overriding concern of any evaluation plan is to *not* overwhelm the subjects with additional work. This is especially true when working with classroom teachers. Frequently, teachers attend inservice programs following a full day of classes and are tired. However, teachers respond positively when they feel the information provided by them is valued and will be used by the project developers.

A substantial amount of data can be gathered quite quickly if the data collection instruments are carefully designed. "Keep it short and simple (KISS)" is a reasonable motto. The evaluator should think carefully about the purpose of each question. How will the data be analyzed, and how will it be used?

It is also important to be aware of the attitude of the subjects you are working with. A volunteer group in general will be more respective than a coerced group. Evaluation of the the CI^3 project suggests that a volunteer group selected to participate via a competitive process will be the most likely to participate in a longitudinal evaluation. (That is, the ideal situation is that the participants are volunteers, and more people volunteer than can be accommodated.)

It is highly recommended that all evaluation information be anonymous. (By this we mean that the facilitator of the inservice should not be able to connect formative and summative evaluation data collected during and after the inservice with specific individuals in the inservice.) It is a fact of life that any evaluation is stressful to people participating in it. Making all data anonymous does two things. One, it helps assure subjects their responses will not result in negative or punitive actions. Two, it creates an atmosphere where teachers are comfortable responding in an honest and frank manner to evaluation questions.

The problem of evaluation stress is compounded when computers are involved. Computer-related inservice can produces high levels of stress because of the difficulty associated with integrating computers into the classroom. The combination of the normal evaluation stress and stress related to computers has the potential for creating an extremely bad situation. Reducing both sources of stress is extremely important if you want to be successful in this major change effort.

An example

In this section we will describe the development of an instrument for evaluating a computer inservice. We include the instrument that was developed and a sample of the outcomes obtained when the instrument was used with a group of secondary school science teachers who were participating in a series of inservice sessions. We will cover purposes, instrument design, file construction, statistical analysis, and interpretation. The ideas illustrated here are equally applicable in inservices in math, science, social studies, elementary education, etc.

The purpose of our evaluations in the CI^3 project was three fold: 1) formative 2) summative and 3) long-term residual. Here we will concentrate on the formative and summative aspects of one workshop devoted to integrating computers into the middle and secondary school science curriculum. The same ideas can be applied to inservices aimed at other groups of educators.

Concern for the participant: Participants do not come to us to be evaluated, they come to learn. One must keep the forms and the evaluation brief. We allow about 40 minutes for the whole process during the eight two-hour inservice sessions, with 20 minutes devoted to mid-course session and 20 minutes devoted to evaluation during the final session. The inservice providers were not in the room during the collection of data; the outside evaluator distributed, collected and analyzed the data.

Form Development: Many of the forms we are using to illustrate the process (a number of additional forms are given in the next chapter) were developed following observations of the sessions. The local evaluator attended the majority of the inservice sessions and had a good idea of what the content was for each session. The specifications driving the writing of the forms were to what the content was for each session. The specifications driving the writing of the forms were to assess 1) quality of the delivery of the information 2) interest of the material to the participant, and 3) relevance of the materials to the teaching tasks of the participants.

An evaluation instrument was developed to specifically fit the software used in the sessions. The science inservice sessions used Macintosh computers and the primary piece of software was MicroSoft Works, an integrated package. Most of the inservice participants did not have access to Macintosh computers in their schools. (This means that modifications of the instrument will be needed to fit other inservices that use different hardware and software, and focus on different subject matter.)

All evaluation instruments should end with a series of open-ended questions. However, it is prudent to restrict the space allowed for writing open-ended responses.

The usual method of form development involves a stage in which there is a pilot test of the form itself. In informal and semi-formal situations, this can be accomplished with a small number of people. The main idea is to be sure that the wording is clear.

Questionnaire specifications: The instrument given in Figure 2 was used to evaluate a computer workshop designed for a mixed audience of absolutely novice and more experienced users of computers. All were middle-school and high-school science teachers. The main long-term goal of the workshop was to increase the use of computer as a tool in the science classes taught by the participants.

The goals of the questionnaire were to evaluate the technical quality of the delivery, the specific action of some of the components, and whether the participants were able to see the major goal of the workshop. There were a few questions aimed at specific problems such as the effect of computer labs on instruction and the problems that participants may have had shifting to an unfamiliar computer. (While a number of participants had encountered the Macintosh before, relatively few had substantial experience with this machine.)

Questions 1, 7, 14, 15, 16, 18, 20, 22, and 25 are directed to the delivery of the workshop. Question 25—I would recommend this workshop session for other teachers—is particularly important. If the responses to this question were negative, then there would have been the need for extensive soul searching and a change in direction.

Questions 4, 8, 10, 11, and to some extent 9, are directed to the type of programs being presented in the first half of the workshop. In these sessions the general presentations covered using the computer and databases. This was what was being taught, it was not negotiable. Negative responses to these questions would have led to a rethinking of the delivery system, not a reemphasis on other materials.

Question 2 and 4, are directed at the general idea of the workshop. These questions were covered more thoroughly in the evaluation at the end of the workshop.

Question 23, 24, 27, and 29, were directed to some problems revolving around transferring from Apple to Macintosh computers. Question 26 was very specific because the evaluator noticed that some of the participants seemed to be having difficulty with the mechanics of typing.

In summary: We expect to ask questions focused at the content of the workshop. We expect to take a very brief look at the effectiveness of the delivery systems, which include the quality of the teaching and the programs demonstrated.

Results: Figure 2 presents the evaluation instrument and sample data collected about halfway through the inservice. The relevant information to examine is the mean responses to each of the Items 1-25. It is well not to overwhelm the user of the data with statistical excesses from packaged programs. The inservice facilitator may be able to modify the inservice sessions in response to major deviations from what was anticipated. Means, rounded to the nearest .5, suffice for this purpose. Of course, some inservice facilitators will want to see more detailed statistics. We have not included additional statistical data here, but the evaluator of the project provided as much detail as the facilitators desired.

Output in the form of Figure 2 contains information that is very helpful. In particular, question 3 reveals that participants see the ability to use computers more in the future as being enhanced. It is quite apparent that the overall evaluation of this workshop is good. The participants feel more confident with computers (Q1), find the material worthwhile (Q14), and see the workshop as relevant. Some of the texture of the situational setting can be found in the participants responses to the questions about availability of computers (Q21 and Q13). Those delivering the workshop should be proud of the responses to Q14, the binder and handout materials are useful; Q16, the workshop lived up to my expectations; and Q25, I would recommend this workshop to others. Responses to all these questions are near the top of the scale.

There are worries; Q2 indicates that they are not using the computer more. Q9 and Q11 indicate that more time should be spent on why databases are needed and the game of the week.

It is important to remember why this particular workshop was selected for illustration. It was the first time the science inservice was offered to a group of teachers, and it was the first time the inservice facilitator was in charge of such an extensive inservice series of sessions. Different computers were used (that is, Macintosh computers instead of the Apple 2 computers that the participants might have anticipated). The second presentation of the material (that is, a replication of the inservice series done the next year) showed that the providers made some changes that were reflected in the participants responses. The evaluator does not recommend cross-group comparisons because conditions and clients are not constant.

Science Inservice Evaluation Instrument (This is the start of Table 2)

(*Note*: This instrument was designed to require about 20 minutes to complete. The small letter "m" in the response field indicates the Mean Response of a group of science teachers who were participating in a sequence of eight two-hour computer inservices.)

Instructions: Please take about 20 minutes of your time to fill out the form. It is designed to help us assess the quality and effectiveness of the inservice, and to improve it. All responses will be confidential. Only summary statistical data and responses that cannot be used to identify specific participants will be provided to the inservice facilitator.

In the following questions, a response of 1 indicates that you strongly disagree with the statement, while a response of 5 indicates that you strongly agree with the statement. A response of 3 is neutral.

		Disagree				Agree
1.	I feel more competent with computers than I did at the start of this workshop.	1	2	3	4 m	5
2.	I am using computers more with my students than I did at the start of the workshop.	1	2 m	3	4	5
3.	As a result of this workshop, in the future I will be able to use computers more with my students.	1	2	3	4 m	5
4.	I can see ways to integrate the programs demonstrated in the workshop into my curriculum.	1	2	3	4 m	5
5.	As a result of this workshop, I have found programs not demonstrated in the workshop and integrated them into my curriculum.	1	2 m	3	4	5
6.	I have been able to interest other teachers in what we have been doing in these workshops.	1	2	3 m	4	5
7.	The sessions contain too much information to absorb comfortably.	1	2 m	3	4	5
8.	I would like to see some programs demonstrated that are	1	2	3	4	5

9.	The Game of the Week has been helpful.	1	2	3	4	5
			m			
10.	The sessions have helped me recognize non-computerized database applications in my classroom.	1	2	3	4	5
					m	
11.	I feel that databases have a legitimate role in science classrooms.	1	2	3	4	5
			m			
12.	Time should be spent exploring practical problems like getting students to the computers.	1	2	3	4	5
				m		
13.	The greatest block to using computers is lack of access.	1	2	3	4	5
				m		
14.	The contents of the binder (the handouts) is worthwhile.	1	2	3	4	5
					m	
15.	The workshop activities are relevant to my current classroom needs.	1	2	3	4	5
					m	
16.	This workshop has lived up to my expectations.	1	2	3	4	5
					m	
17.	I have learned a great deal about computers from other participants in the inservice.	1	2	3	4	5
				m		
18.	We should take more time to explore the programs that we have seen in the workshops.	1	2	3	4	5
			m			
19.	The instructors should have spent more time assessing existing computers skills in the group of participants.	1	2	3	4	5
			m			
20.	The written materials clearly explain the software that we are using during the workshop sessions.	1	2	3	4	5
						m
21.	The district emphasis on computer laboratories for word processing limits access to computers at those times I might use them for science.	1	2	3	4	5
					m	
22.	The progress of the workshop through the computer programs we have explored is slower than I would have liked.	1	2	3	4	5
			m			
23.	Transfer (of my previous computer knowledge) from other computers to the Macintosh was relatively easy for me.	1	2	3	4	5
				m		
24.	Learning the mechanics of using the computer is more the responsibility of the individual teacher (via working outside of the workshop) than it is of the workshop facilitators during workshop sessions.	1	2	3	4	5
					m	
25.	I would recommend this workshop for others.	1	2	3	4	5
					m	

Instructions: The following four questions can be answered Yes or No. Please circle your choice.

(*Note to reader*: The percentages given are data from the same group as above.)

26.	I am a reasonably competent touch typist.	Yes 67%	No 33%
27.	I was familiar with the Macintosh computer before the start of the workshop.	Yes 42%	No 58%
28.	The bulk of the material we have covered was familiar to me before the start of the workshop.	Yes 25%	No 75%
29.	I was familiar with the Apple *II* computer or other computers before the start of the workshops.	Yes 67%	No 33%

Instructions: Please provide brief responses to the following questions. Use the back of the page if necessary.

30. What is the most positive aspect of the workshop?

31. What are the factors most needing improving?

32. Please write up three ideas that you think you have picked up that may be directly applicable to your classes.

33. Any other comments you would like to make would be appreciated.

Table 2: Science Inservice Evaluation Instrument

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5.2
EVALUATION FORMS

This section contains samples of a number of the evaluation forms used during the NSF project inservices.

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Principal Interview Form (Needs Assessment)	2
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Social Studies Inservice Evaluation	15

Principal Interview Form (Needs Assessment)

Name: ________________________________

School: ________________________________

Date: ________________________________

Principal interviews are conducted as part of the needs assessment. The idea is to interview the principals (or other high level school administrators) in the schools of the inservice participants. Ideally, the people being interviewed would also participate in all of the inservice sessions, or at least in a significant number of them. Research suggests that this is highly desirable if the intent is that the inservices will lead to changes in the classroom. School administrators are key educational change agents. Unless they give open and strong support to teachers working to make change in the curriculum, relatively little change is apt to occur.

One typically begins an interview by explaining its purpose and what the information will be used for. The person being interviewed should be assured that the information will be confidential. Some people doing interviewing find it desirable to use a tape recorder. If this is done, be sure to ask the interviewee if he/she minds being recorded. Since direct quotes of the answers are not needed and many people feel uncomfortable talking into a recorder, it is probably better to not make use of a recorder.

When several people are to be interviewed for the same purpose, it is helpful to have a script or a sequence of questions that all will be asked. However, feel free to deviate from the script in order to follow up on important issues.

1. What do you perceive are the most pressing needs related to the use of computers in your school? (*Note*: Presumably the interviewee knows that your orientation is toward instructional uses of computers. However, you might find that the answer provided is oriented toward administrative uses. If so, you might want to try this question again, but emphasizing instructional uses.)

2. Please describe the role and duties of the computer coordinator or computer building representative at your school. (If there is no such person, probe to find the name of the person who tends to do the most in helping the school make instructional use of computers.)

3. Please describe some of the instructional uses of computers currently occurring at your school.

4. What computer equipment is available for use by students and teachers at your school? Where and/or how is it situated?

5. What training has your staff had in the use of computers?

6. What training have you had? (Describe how you use computers to do your job.)

7. Does your school have a written set of long-range plans for instructional use of computers? (If yes, can you provide me with a copy? What are some of its key goals?)

8. Does your school district have a written set of long-range plans for instructional use of computers? (If yes, can you briefly describe the plans?)

9. Are there other important things I should know about instructional use of computers in your school that would be helpful in designing and conducting inservice for your teachers?

School Site Information Sheet

(*Note*: It is often quite desirable to hold inservice sessions in the schools of the participants. This form is designed to aid in collection of information about the computer facilities available in a school that might be available for inservice sessions and/or that might be available to inservice participants for their personal use and use with students.)

Site ______________________ Contact Person ________________________

Which equipment is available? ______________________________________

____

When is equipment available? ______________________________________

____

Where is equipment available? ______________________________________

____

What is the procedure for organizing or obtaining equipment for use in the classroom?

____

____

What is the procedure for securing the lab? ___________________________________

____

What software is available? ____

____

____

How is it obtained? ____

____

Time schedule? (Obtain a copy of the school and its teachers' time schedule.)

CI^3 Teacher Needs Assessment

Name: ______________________________

School: _________________________

(This instrument is designed to be filled out by teachers who might be interested in participating in a computer inservice. One way to make use of this instrument is to meet with the teachers in a school who have expressed some interest in an inservice. Discuss the nature of the types of inservices that might be possible. Answer their questions. Then have each person who might be interested in participating in an inservice fill out the following form. Assure the teachers that the results will be confidential.)

Instructions:
For numbers **1-5** below, please **circle** yes or no.

1. Have you requested that your school or department purchase any software within the last year? **YES** **NO**

2. Have you used the school district's software preview center within the past 12 months? **YES** **NO**

3. Does the integration of the computer in education change the priorities of what should be taught in the curriculum? **YES** **NO**

4. Do you plan to purchase a personal computer within the next 12 months? **YES** **NO**

5. Do you have a computer in your home? **YES** **NO**
   If you circled **YES**,

   (a) What brand and model is it?

   (b) How much is it used, and for what purposes?

   (c) Do you bring it into the classroom? YES NO

Instructions:
For numbers **6-14** below, please write a **brief** answer.

6. List the **subject areas** in your curriculum where you think computer use is currently helping **your students**.

7. List the general types of **computer applications** you think are currently helpings **your students**.

8. List the **subject areas** in your curriculum where you think computer use is currently helping **you**.

9. List the general types of **computer applications** you think are currently helping **you**.

10. List the areas (not necessarily in your classroom) where you might like to use a computer if you could gain appropriate training and access to facilities (ie., any kind of personal use, recreation, database, gradebook, etc.).

11. List the **names** of the computer programs/packages (titles) you have ordered or requested to be ordered for educational/school use in the last year.

12. List the **names** of the top five computer programs/packages (titles) that you use or have used most frequently with your students.

13. (a) List the **names** of the top five computer programs/packages (titles) that you use in your role as an educator or for personal use.

(b) Indicate the **approximate number** of computer programs/packages you use with your classes. _______

(c) Indicate the **approximate number** of computer programs/packages that you use for personal use. _______

14. What kind of inservice or workshops would you like to see in the future? What characteristics and content would they have to have so that you would probably participate on a voluntary basis?

Concerns Questionnaire

Name ______________________________

Date ____________

The purpose of this questionnaire is to determine the concerns people have about future educational innovations. The items were developed from typical responses of school and college educators who ranged from having no knowledge at all about various innovations to many years experience in using them. Therefore, *a number of the items may appear to be of little relevance to you at this time*. For the completely irrelevant items, please circle "0" on the scale. Other items will represent those concerns you *do* have, in varying degrees of intensity, and should be marked higher on the scale, according to the explanation at the top of each of the following pages.

For example:

0	1	2	3	4	5	6	7
	Not true of me now		Somewhat true of me now			Very true of me now	

0 1 2 3 4 5 6 7	This statement is very true of me at this time. (Circle the 7. A slightly less strong response would be given by circling the 6.)
0 1 2 3 4 5 6 7	This statement is somewhat true of me now. (Circle the 4. A slightly weaker response would be given by circling the 3 while a slightly stronger.response would be given by circling the 5.)
0 1 2 3 4 5 6 7	This statement is not at all true of me at this time. (Circle the 1. A slightly stronger response would be given by circling the 2.)
0 1 2 3 4 5 6 7	This statement seems irrelevant to me. (Circle the 0.)

Please respond to the items in terms of *your present concerns*, or how you feel about your involvement or potential involvement with *integration of computers into instruction*. We do not hold to any one definition of this innovation, so please think of it in terms of *your own perception* of what it involves. Because this questionnaire is used for a variety of innovations, the term *computer integration* never appears. However, phrases such as "the innovation," "This approach," and "the new system" all refer to *computer integration*. Remember to respond to each item in terms of your *present concerns* about your involvement or potential involvement with *computer integration*.

Thank you for taking time to complete this task.

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0	1	2	3	4	5	6	7
Not true of me now			Somewhat true of me now			Very true of me now	

0 1 2 3 4 5 6 7	I am concerned about evaluating my impact on students.
0 1 2 3 4 5 6 7	I would like to revise the innovation's instructional approach.
0 1 2 3 4 5 6 7	I am completely occupied with other things.
0 1 2 3 4 5 6 7	I would like to modify our use of the innovation based on the experiences of our students.
0 1 2 3 4 5 6 7	Although I don't know about this innovation, I am concerned about things in the area.
0 1 2 3 4 5 6 7	I would like to excite my students about their part in this approach.
0 1 2 3 4 5 6 7	I am concerned about time spent working with nonacademic problems related to this innovation.
0 1 2 3 4 5 6 7	I would like to know what the use of the innovation will require in the immediate future.
0 1 2 3 4 5 6 7	I would like to coordinate my effort with others to maximize the innovation's effects.
0 1 2 3 4 5 6 7	I would like to have more information on time and energy commitments required by this innovation.
0 1 2 3 4 5 6 7	I would like to know what other faculty are doing in this area.
0 1 2 3 4 5 6 7	At this time, I am not interested in learning about this innovation.
0 1 2 3 4 5 6 7	I would like to determine how to supplement, enhance or replace the innovation.
0 1 2 3 4 5 6 7	I would like to use feedback from students to change the program.
0 1 2 3 4 5 6 7	I would like to know how my role will change when I am using the innovation.
0 1 2 3 4 5 6 7	Coordination of tasks and people is taking too much of my time.
0 1 2 3 4 5 6 7	I would like to know how this innovation is better than what we have now.

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0 1 2 3 4 5 6 7
Not true of me now Somewhat true of me now Very true of me now

0 1 2 3 4 5 6 7	I am concerned about students' attitudes toward this innovation.
0 1 2 3 4 5 6 7	I now know of some other approaches that might work better.
0 1 2 3 4 5 6 7	I don't even know what the innovation is.
0 1 2 3 4 5 6 7	I am concerned about about not having enough time to organize myself each day.
0 1 2 3 4 5 6 7	I would like to help other faculty in their use of the innovation.
0 1 2 3 4 5 6 7	I have a very limited knowledge about the innovation.
0 1 2 3 4 5 6 7	I would like to know the effects of reorganization on my professional status.
0 1 2 3 4 5 6 7	I am concerned about conflict between my interests and my responsibilities.
0 1 2 3 4 5 6 7	I am concerned about revising my use of the innovation.
0 1 2 3 4 5 6 7	I would like to develop working relationships with both our faculty and outside faculty using this innovation.
0 1 2 3 4 5 6 7	I am concerned about how the innovation affects students.
0 1 2 3 4 5 6 7	I am not concerned about this innovation.
0 1 2 3 4 5 6 7	I would like to know who will make the decisions in the new system.
0 1 2 3 4 5 6 7	I would like to discuss the possibility of using the innovation.
0 1 2 3 4 5 6 7	I would like to know what resources are available if we decide to adopt this innovation.
0 1 2 3 4 5 6 7	I am concerned about my inability to manage all the innovation requirements.
0 1 2 3 4 5 6 7	I would like to know how my teaching or administration is supposed to change.
0 1 2 3 4 5 6 7	I would like to familiarize other departments or persons with the progress of this new approach.

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Demographic Self-Description

PLEASE COMPLETE THE FOLLOWING:

1. What percent of your job is:

   Teaching ____% Administration ____% Other (specify)______________%

2. Do you work: full time _____ part time _____
3. Female _____ Male _____
4. Age: 20-29 ____ 30-39 ____ 40-49 ____ 50-59 ____ 60-69 ____
5. Highest degree earned:

   Associate _____ Bachelor _____ Masters _____ Doctorate _____

6. Year degree earned: _____ 7. Total years teaching _____
8. Number of years at present school: _____
9. In how may schools have you held full-time appointments?

   one____ two ____ three ____ four ____ five or more ____

10. How long have you been involved in computer integration, not counting this year?

    never ___ 1 year ___ 2 years ___ 3 years ___ 4 years ___ 5 years or more ___

11. In your use of computer integration, do you consider yourself to be a:

    nonuser ___ novice ___ intermediate ___ old hand ___ past user ___

12. Have you received formal training in computer integration (workshops, courses)?

    yes _____ no _____

13. Are you currently in the first or second year of use of some major innovation or program other than computer integration?

    yes _____ no _____

    If yes, please describe this program briefly.

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Computer Attitudes Survey

Name: ____________________________

School: ___________________________

(*Note*: It is relatively common to administer an attitude scale before and after an inservice, and perhaps a third time for long term follow-up. This is done as part of the summative evaluation of an inservice. As for all collections of evaluative information, participants should be reassured that the information collected will be confidential and will not affect their grade in the inservice. Ideally, this survey form would be administered, collected, and analyzed by someone other than the inservice facilitator.)

Instructions:
Please circle the number that best describes your attitude. If you strongly agree with the statement circle 1 for strongly agree. If you strongly disagree with the statement circle 5. Circle 3 if your attitude toward the statement is neutral.

		Strongly Agree				Strongly Disagree
1.	Computers can improve learning of higher order skills.	1	2	3	4	5
2.	Computers will improve education.	1	2	3	4	5
3	Computers can improve drill and practice.	1	2	3	4	5
4.	Computers will create jobs needing specialized training.	1	2	3	4	5
5.	Computers will improve health care.	1	2	3	4	5
6.	A person today cannot escape the influence of computers.	1	2	3	4	5
7.	Computers will displace teachers.	1	2	3	4	5
8.	Computers will dehumanize society.	1	2	3	4	5
9.	Computers can teach better than teachers.	1	2	3	4	5
10.	Computers are beyond the understanding of the typical person.	1	2	3	4	5
11.	Computers will replace low-skill jobs.	1	2	3	4	5

From *Computer Attitudes Factor Structure in Cognitive and affective computer attitude scales: A validity study.* by S.H. Bannon, J.C. Marshall, and S. Fluegal, 1985, *Educational and Psychological Measurement*, 679-681.

Sample Results from Computer Attitudes Survey

The Computer Attitudes Survey was administered to 28 participants at the beginning and end of an eight-session inservice designed to teach tool use of computers in the curriculum. The table below gives the means of their responses. The last column gives the results of a 2-tail t-test, and indicates a significant change only on the first item.

Item Number	Beginning Mean	Ending Mean	2-tail t-test p =
1.	1.786	1.250	.026
2.	1.857	1.929	.731
3.	1.571	1.714	.355
4.	1.407	1.500	.490
5.	2.036	1.857	.408
6.	1.357	1.429	.691
7.	4.571	4.750	.259
8.	4.179	4.250	.646
9.	4.500	4.643	.460
10.	4.357	4.714	.096
11.	3.321	3.500	.456

Ease of Use Attitude Survey

Name: ________________________

School: ________________________

(*Note*: This attitude survey form could be administered concurrently with the Computer Attitudes Survey. For many teachers, their attitude toward ease of availability and access of computer software and hardware may be a major determining factor in whether they make instructional use of computers for themselves and their students.)

Instructions:
The following activities relate to the ease of using computers and software in your curriculum and classroom. For numbers 1-7, please circle the number that **best** describes your attitude towards each activity. The scale runs from 1 (Very Difficult) to 5 (Very Easy).

		Very Easy				Very Difficult
1.	Obtaining a computer and monitor for use in my class is	1	2	3	4	5
2.	Obtaining the proper software is	1	2	3	4	5
3.	Scheduling the use of the computer lab for my class is	1	2	3	4	5
4.	Obtaining time for setting up the computer in my class is	1	2	3	4	5
5.	Obtaining time for learning how to use and review new software is	1	2	3	4	5
6.	Obtaining time for using the computer within the present curriculum is	1	2	3	4	5
7.	Using a computer and software in my class is	1	2	3	4	5

8. The number of machines available for use in my classroom is __________.

9. The number of teachers who share the available machines is __________.

Participant Log Sheet

(*Note*: Participants were requested to keep a daily log of their computer use and related activities during the weeks of the inservice sessions. These were turned in each week and provided the inservice facilitator with valuable, formative evaluation information.)

Name ________________________________ Date _____________

Please use this form to record **all** of your computer-related activities, both at school and at home, during the week. This log sheet is not used for grading purposes. Its purpose is to provide formative evaluation information to the inservice facilitator.

Monday

Tuesday

Wednesday

Thursday

Friday

Weekend

Use back of sheet for notes, additional comments, and questions you would like to ask the inservice facilitator.

Social Studies Inservice Evaluation Form

(*Note*: A formative evaluation form of this sort can be used in almost any inservice directed toward helping participants learn to make increased and appropriate instructional use of computers in their classrooms. The sample form provided here was designed for use in an inservice for secondary-school social studies teachers. With slight modification it can be used in a math, science, elementary school, etc. inservice. Participants should be assured that their answers will be kept confidential and will have no bearing on their grade in the inservice, if grades or other requirements have been established for satisfactory completion of the inservice. It is desirable that this form be administered and compiled by someone other than the inservice facilitator. The inservice facilitator should only receive summary statistical data and participant comments that cannot be associated with specific participants. Note also that the same form could be used several times during an inservice that extended over a number of sessions.)

Name: ____________________________

School: ___________________________

We are interested in your overall evaluation of this workshop. For numbers 1 - 34, please circle the number that best describes your attitude. If you agree with the statement, circle 5 for agree. If you disagree with the statement, circle 1. Circle 3 if your attitude toward the statement is neutral.

		Disagree				Agree
1.	I feel more competent with computers than I did at the start of this workshop.	1	2	3	4	5
2.	My students have increased their classroom use of computers as a result of this workshop.	1	2	3	4	5
3.	Lack of student access to computers is the greatest block to my integrating computers into the curriculum.	1	2	3	4	5
4.	I feel competent integrating the software programs and activities demonstrated in the workshop into my teaching.	1	2	3	4	5
5.	I have sought out and located software programs not demonstrated in the workshop and integrated them into my curriculum.	1	2	3	4	5
6.	I have been able to interest other teachers in what we have been doing in these workshops.	1	2	3	4	5
7.	Too much information was presented during the sessions to absorb comfortably.	1	2	3	4	5
8.	I would like to see the workshop demonstrate software programs and activities more directly related to my content area.	1	2	3	4	5

	Disagree				Agree
9. Time should be spent exploring practical problems like getting students to the computers.	1	2	3	4	5
10. As a result of this workshop I will increase my instructional use of computers with my students.	1	2	3	4	5
11. The contents of the participant notebook and handouts will be useful in planning and developing computer related activities for my classes.	1	2	3	4	5
12. I have started collecting computer software disks.	1	2	3	4	5
13. This workshop has lived up to my expectations.	1	2	3	4	5
14. I have learned a great deal about computers from other participants in the workshop.	1	2	3	4	5
15. More time should have been set aside for participants to explore the software programs and materials demonstrated during the workshop.	1	2	3	4	5
16. The written materials clearly explain how to move through the programs.	1	2	3	4	5
17. The progress of the workshop is slower than I would have liked.	1	2	3	4	5
18. The information presented in the sessions is relevant to my classroom.	1	2	3	4	5
19. I would recommend this workshop to other teachers.	1	2	3	4	5
20. I am not convinced that computers will increase student achievement in my content area.	1	2	3	4	5
21. I now talk more to other teachers about computers than I did at the start of the workshop.	1	2	3	4	5
22. Money for computers should be shifted from other areas of the school budget.	1	2	3	4	5
23. The instructors should have spent more time demonstrating a greater variety of software.	1	2	3	4	5
24. The greatest block to my using computers in the classroom is my philosophical disagreement with their worth in my content area.	1	2	3	4	5
25. The progress of the workshop is faster than I would have liked.	1	2	3	4	5

		Disagree				Agree
26.	Lack of teacher access to computers is the greatest block to my using computers.	1	2	3	4	5
27.	I would like a workshop leader to come into my classroom and demonstrate a lesson using the computer as an instructional tool.	1	2	3	4	5
28.	I feel more comfortable using computers with my students than I did at the start of the workshop.	1	2	3	4	5
29.	I am willing to have someone come into my classroom and observe me using computers with my students.	1	2	3	4	5
30.	I am more inclined to let students use computers to develop an understanding of concepts and ideas than I was at the start of the workshop.	1	2	3	4	5
31.	I would have liked time during the workshop to modify and/or develop computer activities for use in my classroom.	1	2	3	4	5
32.	I would prefer that all workshop participants be teaching the same courses and grade levels.	1	2	3	4	5
33.	I found it easy to get access to computer hardware and software between sessions to try out ideas we learned in the workshop.	1	2	3	4	5
34.	I would be more likely to use computers if there was a computer resource person I could consult with at my school.	1	2	3	4	5

For questions 35 - 40, please circle yes if you agree with the statement and no if you disagree with the statement.

35.	I have spent more time watching others use the computers in the workshop than I have spent in using them myself.	Yes	No
36.	The goal of this workshop should be developing teacher skills in the practical use of the computer.	Yes	No
37.	I felt pressure to attend this workshop from other sources.	Yes	No
38.	I would rather spend more time with the computers and less time concerning ourselves with issues such as other resources in the school.	Yes	No

39. The goal of this workshop should be developing an understanding of how to integrate computers into my content area. Yes No

40. I have increased my understanding of how to use computers as a problem solving tool as a result of this workshop. Yes No

For numbers 41 - 48, please circle the number the best describes your attitude toward each of the software programs listed. If you think the program was excellent, circle 5 for excellent. If you think the program was poor, circle 1. Circle 3 if your attitude toward the program is neutral. Please do not refer to your handouts or notebook; we are interested in how you remember these software programs.

		Poor				Excellent
41.	United States Database	1	2	3	4	5
42.	North American Database	1	2	3	4	5
43.	President Elect	1	2	3	4	5
44.	The Other Side	1	2	3	4	5
45.	U.S. History	1	2	3	4	5
46.	Easy Graph	1	2	3	4	5
47.	MECC Graph	1	2	3	4	5
48.	Bank Street File	1	2	3	4	5

Please write brief answers to the following questions.

1. Has the workshop been relevant to your needs?

2. Has the workshop been organized in a way that facilitated learning? If not, how can we improve it?

3. Please write a short description (two or three sentences) of what you perceive as the purpose of the workshop.

4. Identify the most positive aspect(s) of the workshop.

5. Please describe two or three ideas demonstrated during the workshop that are directly applicable to your classes.

6. What can we do to improve this workshop and others like it?

7. Please feel free to make any general comments about the inservice.

5.3

LONG TERM FOLLOWUP EVALUATION

As indicated in Section 5.1, relatively few inservice projects conduct meaningful long-term followup evaluation to determine possible effects of the inservice. The NSF project conducted quite a bit of long-term followup evaluation. Most of this research was conducted by two graduate students who were employed by the project and conducted the evaluations as part of their Ph.D. dissertation research. The references to their Ph.D. dissertations are given below. Each of these dissertations is available for $20 from the International Society for Technolgoy in Education, 1787 Agate Street, Eugene, Oregon 97403-9905.

Hanfling, S. S. (1986). *A formative evaluation of elementary and secondary staff development inservices on integrating computer innovations into the curriculum.* Doctoral Dissertation, University of Oregon.

Johnson, V. P. (1988). *An exploratory case study describing the long-term residual effect of the computer-integrated instruction inservice (CI^3 project).* Doctoral Dissertation, University of Oregon.

The following pages contain some of the instrumentation that was used in the long-term evaluation. Much more detail is provided in the Ph.D. dissertations. Readers interested in the details of such long term evaluation are well advised to begin by reading Vivian Johnson's dissertation.

Title	Page
CI^3 Inservice Participant Focused Interview (Long Form)	2
CI^3 Inservice Participant Focused Interview (Short Form)	7
CI^3 Project Long-Term Assessment	9

CI^3 Inservice Participant Focused Interview
(Long Form)

Site: ______________________ Date: ____________________

Subject: ____________________ Researcher: ______________

Introduction

Purpose	This interview is part of the CI^3 inservice follow-up. The interview is a major source of data to help us determine the residual effect of the inservice you completed.
Topics to be covered	Interview questions will briefly cover the following topics: your teaching experience, your experience with computers, features of the inservice, your attitude and expectations about using computers in education, and how completing the inservice affected you. If there is time available at the end of the interview, please feel free to go back and provide more detail on specific questions.
Ethics	I would like to tape record this interview only for the purpose of validating the accuracy of my questions. The taped interview will be heard by only myself and (list and other names and explain why they may also listen to the recording). Your name will never be mentioned, nor will any particular response be connected to you. In addition, you may turn the tape recorded off at any time.
Concerns of respondent	Do you have any questions or concerns before I begin?

Experience (Time allocation five minutes)

Teaching — How long have you been teaching (brief)?

Computers — Briefly describe your experience with computers.

If experienced, what brands of computers do you feel ***comfortable*** using?

___ Apple

___ Atari

___ Commodore (PET)

___ Macintosh

___ IBM

___ Radio Shack

___ Commodore C-64

___ Other (Note Brand)

Inservice Features (Time Allocation five-seven minutes)

Content — What did you perceive as the ***subject*** of the inservice you completed?

Positive features — What were the ***features*** that made the inservice work best for you? Examples?

(As a backup, show list of inservice features and ask: Do you remember any of these features?)

Limitations — What ***features*** of the inservice ***limited*** its success?

(As a backup, show list of features and ask: Others say these features are the most important, what would you add or delete? Did your inservice have these?)

Changes over time	Would your answers have been different just after you finished the inservice?
Attitudes and Expectations	(Time allocation ten minutes)
Computers in education	What do you think we should be doing with computers in education?
	Probe to elicit teachers' perceptions of the appropriate use of computers for enrichment, remediation, and regular instruction.
	If time permits suggest teachers describe some specific examples of appropriate uses.

Teaching	What would you like to be doing with computers in your own classroom?
Effect on students	What effect will classroom use of computers have on your students? How will they respond? What will they learn?
Reason for inservice	Why did you sign up for the inservice? Was it voluntary? __ yes __ no
Anticipated Outcomes	What did you hope to learn? What did you hope to be able to do?
Outcomes	(Time allocation 15 minutes)
Expectations	Did you learn what you hoped to learn? Why? Why not?
Knowledge and Skills	Describe what you learned? What facts and skills?
Teaching	Did the inservice affect the way you teach? Either how you teach or what you teach?
Students	Name the computer applications that you feel are the most beneficial to your students? (Provide only word processing as an example of a computer application.)

	Have you seen changes in your students since using computers in the class? (Possible examples: student's attitude toward school, toward learning, toward subject matter.)
Plans	What do you plan to be doing with computers in the future?
Problems	What factors influence your choice to use or not use computers in your classroom?
	(If participants have difficulty answering this questions—suggest they think about the following: access to computers, time issues, support from school administration, etc.
	What problems have you had trying to use computers that the inservice did not prepare you to solve?
Changes in inservice	How would you change the inservice? (Omit if time becomes a problem)
Final Instructions	We are at the end of the interview, is there anything else you would like to mention or a question you wish to go back to?
	Please thank the individual for their time and input and tell them they have been very helpful.

CI^3 Inservice Participant Focused Interview
(Short Form)

Name: ______________________

School: ______________________

Date: ______________________

Instructions:

Instruct the participant to answer the following questions as briefly as possible. (*Note*: Use the same confidentiality discussion as is given with the Long Form.)

1. Describe the purpose of the CI^3 computer workshop.

2. State why you participated in the CI^3 computer workshop.

3. List three changes, in you as an individual or teacher, that can be **attributed** to your participation in the CI^3 sessions.

   a)

   b)

   c)

4. Identify the three most important experiences that occurred during the training.

   a)

   b)

   c)

5. List the **subject areas**, identified in the training, where computer use benefits **your students**.

6. List the **computer applications,** identified in training, that benefit **your students**.

7. List the **subject areas,** discussed in training, where you think computer use **benefits you**.

8. List the **computer applications,** utilized in training, that **benefit you**.

9. Do you feel you know enough about computers to make **effective** use of them in **your** teaching?

10. How has the **non-computer content** of what you teach been affected by your increasing computer knowledge?

CI^3 Project Long Term Assessment

Name: ____________________

School: __________________

Instructions for Part 1:
For numbers **1-9** below, please ***circle*** yes or no.

1. Do you still have, use, or reference the **computer workshop** handouts/materials?
   YES **NO**

2. Prior to the computer workshop, was there an in-school computer interest or support group at your school?
   YES NO

3. Following the completion of the workshops, has a computer interest or support group been formed?
   YES NO

4. Have you requested that your school or department purchase any software within the last year?
   YES NO

5. Do you use the school district's software preview center?
   YES NO

6. Do you have a computer in your home?
   YES NO

   If you circled **YES**,

   (a) What brand and model is it?

   (b) Do you bring it into the classroom?
   YES NO

7. Do you plan to purchase a personal computer within the next 12 months?
   YES NO

8. Does the integration of the computer in education change the priorities of what should be taught in the curriculum?
   YES NO

9. Do you feel that you know enough about computers to make effective use of them in your teaching?

YES **NO**

10. (a) List the **names** of the top five computer programs/packages that you use either in your role as an educator or for personal use.

(b) Indicate the **approximate number** of computer programs/packages you use with your classes.

______

(c) Indicate the **approximate number** of computer programs/packages that are for your personal use.

______

11. List the **names** of the top five computer programs/packages (titles) that you use or have used most frequently with your students.

Instructions for Part 2:
Please answer each of the following questions with a checkmark (√) .

1. Before the inservice sessions, how involved were you in integrating computers into your curriculum?

   ___ none ___ slightly ___ somewhat ___ very

2. Since the inservice training, have you increased your involvement in the integration of computers into the curriculum?

   ___ none ___ slightly ___ moderately ___ much

3. Before the training, were you part of a local computer support group?

   ___ Yes ___ No

4. Since the training, have you been involved in starting a local computer support group or become a member of one?

   ___ Yes ___ No

5. Since the inservice sessions, have you increased you communications with others about integrating computers into the curriculum?

   ___ Yes ___ No

   If you checked "yes" to question number 5, please indicate the approximate number of people you have communicated with in each of the following categories:

Approximate Number of People	**Categories**
________	Shared information with people unaware of how to integrate computers into the curriculum.
________	Exchanged information with people already involved with integrating computers into the curriculum.
________	Contacted other inservice session participants.

6. Have you used any of the materials you received at the inservice sessions?

   ___ Yes ___ No

   If you checked "yes," how useful did you generally find the materials to be? Please check one.

   ___ Useless ___ Hardly useful ___ Somewhat useful ___ Very useful

7. Do you think the type of training you received helps to promote computer integration into the curriculum?

   ___ Yes ___ No

Read Me First

This folder contains MacDraw II files for several instruments that are useful in gathering evaluation data from students and teachers. Vivian Johnson developed these instruments for use in her Ph.D. dissertation work.

Weekly Checklist

Name: ______________________ Week of: ______________________

	Teacher Computer Activities						Student Computer Activities										
Day	Attendance	Grades	Prod. Classroom Materials	Ordering/Previewing. Computer Software	Reading/Studying About Computers	Non Class Related Word Processing	Computer Art	Computer Assisted Instruction (CAI)	Graphing	Computer Literacy	Database Activities	Drill & Practice	Spreadsheet Activites	Simulation	Tutorial	Word Processing	Additional Comments
Mon.																	
Wed.																	
Fri.																	
Weekend																	

Computer Uses for Teachers

Please fill out the following chart to indicate where you use a computer and for what reasons. For each computer application listed on the left:

1) List the number of days per month at each location.
2) Put an "X" under "Personal Use" if you use a computer for any of the application listed for non-school activities.
3) Check (√) each type of curriculum development use for every application used in the classroom.

	Location Days/Months					Instructional Objective					
Types of Software For Instructional Use	In Your Room	In a Computer Lab	At Home	Resource/ Staff Room	Personal Use	Introduce a Concept	Explore a Concept	Reinforce a Concept	Test	Demonstration	Extra Credit/ Motivational
Database Manager (with Mail Merge)											
Gradebook Program											
Word Processing											
Spreadsheet											
Classroom Materials (Overheads Worksheet Generator Handouts)											
Attendance/ Recordkeeping											
Telecommunications											
Entertainment											

Computer Uses with Students

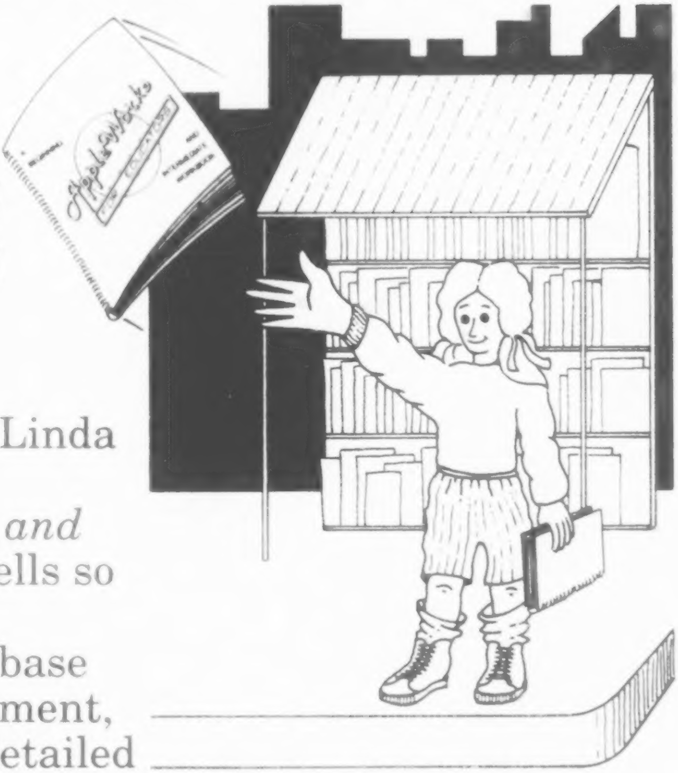
Please fill out the following chart. For each computer application listed on the left, fill in the following:

1) Estimate the number of days per month you use the computer for each application listed (do not count the number of times used per day).
2) Place an "X" under the heading that indicates how students use the computers.
3) Place an "X" under the heading that indicates how you use the computer in each case.

Note: See example below.

	Location days/month		How Student's Use Computer			How You Use Computer						
Computer Applications	In Your Classroom	In a Computer Lab	Individually	Groups	Whole Class	Introduce a Concept	Explore a Concept	Reinforce a Concept	Test	Demonstration	Extra Credit/ Motivational	Skill Practice
Example: Programming	3	8	x		x	x		x		x	x	
In the above example, the respondent noted: three days per month of programming in the room and eight days per month in the computer lab. Student's use was individually and as a whole class. The instructional ojectives were to: explain a concept, reinforce a concept, demonstration and for extra credit.												
Programing (logo)												
Typing												
Drill-and-Practice Tutorial Simulation Educational Game												
Student Word Processor (Story Writing)												
Database												
Spreadsheet												
Graphing Packages												
Computer Art (Koala Pad)												
Computer Literacy												

AppleWorks for Educators—A Beginning and Intermediate Workbook hits ISTE's best-seller list.



Over 20,000 copies sold!

There's a good reason Linda Rathje's *AppleWorks for Educators—A Beginning and Intermediate Workbook* sells so well. It works.

Word processing, database and spreadsheet management, and printer options are detailed step-by-step. Both novice and experienced AppleWorks users benefit from the depth and strength of the material.

AppleWorks for Educators—A Beginning and Intermediate Workbook has been revised to include a mail merge section, expanded integration activities, glossary, and up-to-date articles from *The Computing Teacher*.

Move *AppleWorks for Educators—A Beginning and Intermediate Workbook* to the top of your reading list.

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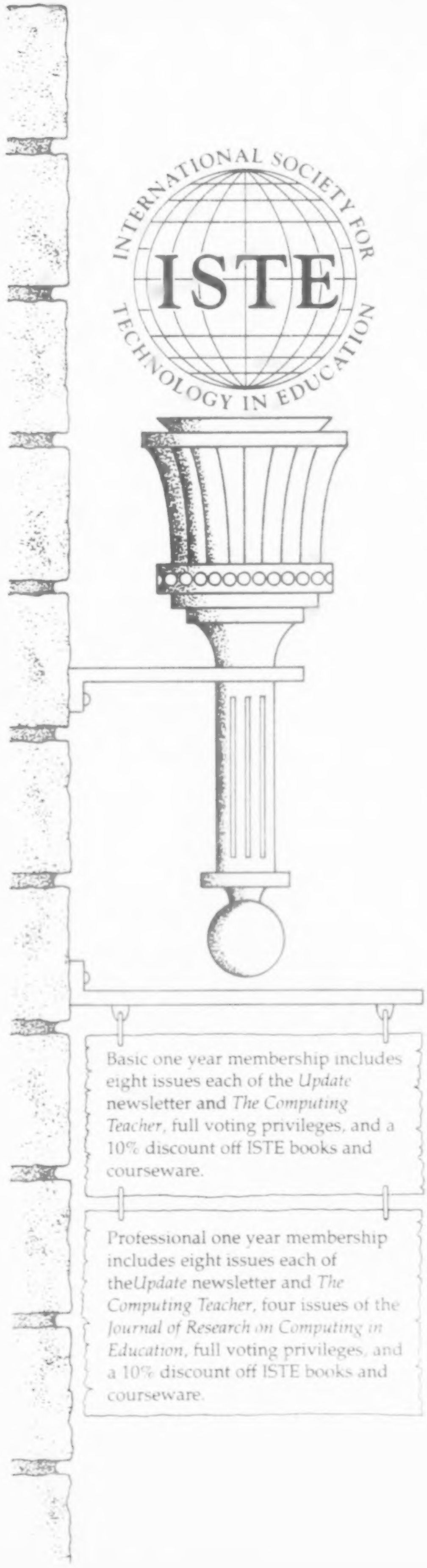

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